IN THE

Supreme Court of the United States

October Term, 1944

No. 50

THE DOW CHEMICAL COMPANY, A CORPORATION,
Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,
Respondent.

No. 61

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,
Cross-Petitioner,

vs.

THE DOW CHEMICAL COMPANY, A CORPORATION,
Cross-Respondent.

BRIEF ON BEHALF OF DOW CHEMICAL COMPANY

RUSSELL WILES,
WILBER OWEN,
Counsel for Petitioner and Cross-Respondent.

CHRITTON, WILES, DAVIES, SCHROEDER & MERRIAM,
Board of Trade Building,
Chicago, Illinois,

OWEN & OWEN,
Nicholas Building,
Toledo, Ohio

CALVIN A. CAMPBELL,
DON L. CONNER,
Midland, Michigan,
Attorneys for Petitioner and Cross-Respondent.

IN THE

Supreme Court of the United States

October Term, 1944

No. 50

THE DOW CHEMICAL COMPANY, A CORPORATION,

Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,

Respondent.

No. 61

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,

Cross-Petitioner,

vs.

THE DOW CHEMICAL COMPANY, A CORPORATION,

Cross-Respondent.

BRIEF ON BEHALF OF DOW CHEMICAL COMPANY

RUSSELL WILES,
WILBER OWEN,
Counsel for Petitioner and Cross-Respondent.

CHRITTON, WILES, DAVIES, SCHROEDER & MERRIAM,
Board of Trade Building,
Chicago, Illinois,

OWEN & OWEN,
Nicholas Building,
Toledo, Ohio

CALVIN A. CAMPBELL,
DON L. CONNER,
Midland, Michigan,
Attorneys for Petitioner and Cross-Respondent.

INDEX

ARGUMENT

BRIEF FOR CROSS-RESPONDENT ON QUESTION OF INFRINGEMENT

CROSS-PETITIONER'S PROCESS INFRINGES

TABLE OF CASES

IN THE

Supreme Court of the United States

October Term, 1944

No. 50

THE DOW CHEMICAL COMPANY, A CORPORATION,

Petitioner,

vs.

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,

Respondent.

No. 61

HALLIBURTON OIL WELL CEMENTING COMPANY, A CORPORATION,

Cross-Petitioner,

vs.

THE DOW CHEMICAL COMPANY, A CORPORATION,

Cross-Respondent.

BRIEF FOR PETITIONER ON THE QUESTION OF VALIDITY

OPINIONS BELOW

The opinion of the Sixth Circuit Court of Appeals in this case holding Grebe and Sanford patent No. 1,877,504[1] invalid is reported in 139 Fed. 2d 473, 60 U. S. P. Q. 90. (R. 2052.) The opinion of the Tenth Circuit Court of Appeals holding the same patent valid in an earlier case is reported in 81 Fed. 2d 495.

The views of the trial court in this case were expressed in connection with the disposition of findings of fact presented by the respective parties and appear in Volume III of the Record at pages 1435 to 1477.

---

(1) R. 1501.

JURISDICTION

The opinion on appeal was filed December 17, 1943, and plaintiff's petition for rehearing was denied January 31, 1944. Plaintiff's petition for *certiorari* and defendant's cross-petition were both granted May 15, 1944. (322 U. S. ....) The jurisdiction of this court is confirmed by Section 244(a) of the Judicial Code as amended February 13, 1925, 28 U. S. C. Section 347.

THE QUESTION PRESENTED

The sole question presented by the petition is whether or not the Grebe and Sanford patent involves invention. The cross-petition raises the issue of infringement, which is considered in a separate part of this brief.

STATEMENT OF THE CASE ON THE PETITION

Petitioner sued respondent in the District Court for the Eastern District of Michigan, charging infringement of the Grebe and Sanford patent.(2) Both invention and infringement were denied. The trial court held the patent invalid for want of invention and that conclusion was affirmed on appeal.

The Tenth Circuit Court of Appeals had previously held the patent valid in *Dow Chemical Company vs. Williams Brothers,* 81 Fed. 2d 495, and as will appear later there is a fundamental disagreement in the legal positions of the two courts on the question of validity on substantially the same records. What additional evidence there is here on that issue will be reviewed in connection with the subjects to which it relates.

---

(2) Other patents were involved in the trial and were disposed of by parts of the decree not appealed from. The above patent was the only one before the Circuit Court of Appeals.

The bulk of the record in pages relates to infringement. In the Tenth Circuit case infringement was not contested, and there has been no conflict of opinion on infringement by the process involved here. In this case both the trial and appeal courts held that the patent, if valid, would have been infringed by defendant's process.[3] Therefore, under numerous precedents of this court relating to concurrent findings of fact the issue of infringement is not believed to be open here, even though respondent's cross-petition for *certiorari* was granted. Nevertheless, in view of the granting of the cross-writ, infringement is separately briefed. (*Infra*, p. 62 *et seq.*)

There has been no suppression of the invention, no pooling and no suggestion of improper use of the patent. The invention has been made easily available to the entire oil producing industry through the issuance of a number of licenses on fair terms and it has been widely adopted and used.

The Patent in Suit

The patent is for a method of treating deep wells to increase their production. Upon the development and testing of the patented process, it immediately went into very widespread, indeed practically universal, use in oil and gas wells producing from limestone formations. Seldom has a new process received the tribute of such immediate and widespread acceptance. It has added enormously to our national wealth and aided greatly in the conservation of our resources. Without the increased oil production brought about by its use, our present petroleum shortage would indeed be desperate.

To understand the process one must know something about oil wells. Modern oil wells range in depth from 1200

(3) Finding 84 (R. 1490), conclusion 2 (R. 1492, 2054).

or 1500 feet to more than 10,000 feet. In each the hole is cased with a steel pipe 6 to 12 inches or more in diameter, which generally extends down to the top of the producing formation. Within this casing is a steel pump tube usually 2 to 3 inches in diameter, which extends from the top of the well to below the bottom of the casing. This tube carries a pump near its lower end, although in a free flowing well the pump is omitted until the flow falls enough to require pumping. Oil enters through a perforated section of tubing located below the pump, which is operated by a pump rod running through the tubing.[4]

In practicing the process of the patent the pump rod and valves are removed and a quantity of dilute commercial hydrochloric (muriatic) acid, to which has been added an inhibitor, is run or pumped into the regular well tubing and forced by pressure out through the perforated section of tubing and into the oil-producing formation surrounding the well hole where it enlarges the pores and forms new channels by eating away the limestone, thereby facilitating the flow of oil to the well. By virtue of the dilution of the acid it readily enters the earth formation and the resulting spent solution is easily purged from the formation when the pressure is released. The inhibitor prevents the acid from attacking and damaging such metal equipment of the well as the pump tubing, well casing, etc., but does not affect the action of the acid on the limestone.

In spending itself on the limestone the acid forms carbon dioxide gas and calcium chloride. The calcium chloride dissolves in the water of the acid solution to form the spent acid solution and the pressure is usually sufficient to hold the carbon dioxide gas in this solution.

The strength of the acid solution varies with the amount of water added to commercial hydrochloric acid,

[4] See drawing of Grebe patent 1,916,122. (R. 1506.)

which generally contains around 30% of the acid ingredient HCl. The patent states that the preferred strength of the acid is between 10% and 15% concentration, the broad range being between 5% and 20%, which is the range called for in some of the claims. Approximately 15% acid is used by petitioner and its licensees and by respondent.

The preferred corrosion inhibitor is metallic arsenic, but the patent states that other inhibitors may be used, naming several. Some of the claims limit the inhibitor to arsenic, but others are broad as regards the inhibitor.

The patent contains only process claims, of which Nos. 1, 5, 7, 8 and 9 are in suit. The Tenth Circuit Court of Appeals held the patent valid over all the art here presented. Although recognizing that the question of invention was close, it resolved the doubt in favor of the patent because an urgent need for a workable process to increase the production of petroleum from limestone wells had existed for more than a third of a century with the means adopted by Grebe and Sanford for its solution readily at hand during the entire period. The fact that no one had discovered and applied their simple solution convinced that court that it was not obvious to those skilled in the art of oil production.

Instead of proving that the solution of the problem was simpler than it was considered to be by the court in the Tenth Circuit, the additional evidence here strongly confirms the conclusion of that court that the only previous effort to increase the production of limestone wells by the use of hydrochloric acid was "cumbersome and expensive, and probably impracticable * * *."[5] Additional evidence here strongly confirms this conclusion and shows an even greater need for the Grebe-Sanford invention than appeared in the Tenth Circuit, yet the courts below disre-

[5] Frasch patent 556,669. (R. 1935.)

garded the "long felt want" rule and applied instead the dangerously unreliable rule of "retrospective simplicity."

The history of petroleum production and recent decisions of this court, as well as earlier ones, support the application of the long felt want rule to the facts presented here.

Production of Petroleum

Crude petroleum is seldom, if ever, found in large pools, but instead saturates and fills the small openings or pores in somewhat permeable sandstone and limestone rock strata. In many new wells the underground pressure is sufficient to force the oil up to the top of the casing, where it flows out by itself with no assistance. In such cases the pump tube and pump are omitted. Eventually the flow decreases, partly because of a loss of underground pressure, and pumping becomes necessary. As oil is pumped out, the underground flow to the well decreases and the yield falls off. At length the oil seeps so slowly into the well that the yield falls to a point where it no longer pays to pump the well, which must then be abandoned.

This is the history of nearly every oil well—gradually declining yield until it scarcely pays to operate it, and finally complete practical exhaustion. Obviously, crude oil prices will affect the time for abandoning any given well. With high prices it may pay to keep a well running a long time with trifling production. Obviously, too, comparatively shallow wells can profitably be pumped longer than deep wells. But the end is always the same.

The oil deposits which were first discovered and which are still the most numerous are in sandstone, but at present about one-quarter to one-third of our oil comes from limestone, and it is to the recovery of that oil that the invention in suit is directed.

It has long been known that when a well or a field containing many wells is exhausted a large part of the oil in the rock is still left unrecovered and, by ordinary means, unrecoverable. Nobody believes that more than half is recovered and common estimates on commercial recoveries run all the way from 10% to 40%. Prior to the introduction of the process of the patent in suit it was believed that the recoveries from limestone fields ran only a little more than 30%. (R. 18, 29, 30.)

The recovery of this vast amount of untouched oil always has been a matter of prime importance to the oil industry. America's first well, the Drake, went into production in 1859, and soon thereafter decreases in yields became evident.

The certain knowledge that every field, no matter how far its production may have fallen, still contains at least as much oil as has ever been taken out makes this problem of additional recovery one of the most important of all the unsolved riddles of industry.

Manifestly, the exhaustion of a well or a field is always a serious matter to the owners. It is of little moment that another field may have been discovered to maintain national production. When the owner's daily yield of oil falls off and finally vanishes it is a calamity to him and the knowledge that there is still underground two or three times as much oil as he has obtained has naturally led to numerous efforts to recover that vast remainder.

In addition to the constant pressure on individual owners to restore their own vanished production, the whole country has from time to time had such low proven oil reserves that the country has several times faced imminent exhaustion of our national oil supplies. (R. 28.) Fortunately, old fields have been extended and new fields discovered so as to push the danger of national shortage

further and further away, although the present war demand is again periling our petroleum resources.

Efforts to Solve the Problem

The efforts at solutions have been legion. As early as 1865 methods for increasing yield began to be used and patented. At first, explosives were discharged in the well hole to shatter and crack the adjacent rock. Shooting tends to make a few large cracks rather than to enlarge and open innumerable small channels. It helps production somewhat, but its effect is more or less local. Obviously, however, this cannot greatly affect oil held in tiny pores throughout the vast rock strata. Nevertheless, shooting wells has been common practice for probably eighty years. (R. 19, 1522.)

Flow also has been somewhat increased by closing the top of the well casing and producing a partial vacuum in it by pumping. However, since a perfect vacuum is only 15 pounds per square inch below atmospheric pressure and since the weight of overlying rock subjects any layer to very high pressures, the percentage by which pressure in the well can be reduced by vacuum is so small that it makes comparatively little difference. (R. 21-23.)

Efforts also have been made to increase oil recoveries by forcing either gas or water into the formation to drive the oil to producing wells. Occasionally these efforts at repressuring have been beneficial, but all too often the rock has cracks into which the fluids find their way and through which they escape without doing any good. (R. 24.) Even when successful, repressuring involves large capital expenditures for pumping machinery and auxiliary equipment and can only be applied to a group of wells or an entire pool. Furthermore, this equipment must be operated for some time before substantial results are obtained and

must be kept in operation in order to maintain production.

Also, various efforts have been made to heat the rock around a central producing well and by a combination of distillation and pressure to force the oil into that well. Still other efforts have been made to mine the oil bearing strata by driving shafts and tunnels into which the oil can seep. (R. 25-27.)

The patent art shows an even greater variety of schemes to get more oil out of the ground. (R. 45-55, 1521-30, 1533-77.) Prior to the invention in suit patents relating to treating wells to increase recovery numbered about 200. (R. 57.) Some patents recommend building a fire in the well to heat the surrounding rock and make the oil flow more freely. Others propose to heat the rock by passing electric currents through it. A number of patents outline schemes of heating the formation by introducing steam. Some patents suggest the use of benzene to dissolve paraffin deposits and permit an easier flow. Others suggest the use of gas pumped into a formation to drive the oil before it, and several patents describe forcing water into the rock to wash out the oil.

Of all these prior art methods the only ones ever to yield substantial success are shooting and repressuring, and shooting is the only one that ever went into general use in limestone fields. Now, shooting has been largely superseded in limestone fields by acidizing, which was introduced by petitioner in 1932. (R. 25, 237.)[6]

In sharp contrast with the high capital expenditure for equipment and the time and continued expense involved in repressuring operations, acidizing can be applied to individual wells at small expense and, when successful, yields

---

[6] The record contains data relating to new oil wells in one Michigan field for the period 1928 to 1940, inclusive. While some new wells were "shot" up to and including 1932, the year when the Grebe-Sanford acidizing process was first used, none were shot after that year and many were acidized. During the five years beginning with 1936 every new well was acidized. (R. 168.)

an immediate flush return with no capital outlay for well equipment and no operating cost to the well owner.

The Frasch Process and Patent

In 1896 patent No. 556,669 issued to Herman Frasch, with a half interest assigned to John W. Van Dyke. (R. 1935.) Frasch was the leading industrial chemist of his day. He was closely associated with the early Standard Oil group and is generally credited with having turned Ohio oil into a useful product by inventing a process for removing the sulphur. (R. 1041.) This process not only freed the oil from its intolerable odor but made it possible to burn the kerosene produced from it in a lamp without the white deposit characteristic of sulphur on the lamp chimney. (R. 1057.) Frasch also invented the modern process of recovering sulphur from underground deposits and that invention created our American sulphur industry. For these and other achievements he was awarded the Perkin medal, the highest honor a chemist can receive.

For more than thirty years prior to the date of the Grebe-Sanford invention Van Dyke was in a position to commercialize any process for increasing the output of oil wells which promised success. He was a leading member of the old Standard Oil organization and upon the dissolution of the Standard Oil Company in 1911 became president of Atlantic Refining Company, the Pennsylvania fragment of the old company, and later became president of its producing subsidiary, Atlantic Oil Producing Company, in which positions he continued for many years. (R. 1037, 1161.)

This Frasch patent has been the principal prior art reference in both suits on the Grebe-Sanford patent. In the Tenth Circuit case, where there was no evidence of an attempt to practice the Frasch process, the court stated:

> "Frasch's method was cumbersome and expensive, and probably impracticable because of the inherent difficulty in adequately sealing off the acid at the bottom of the hole. In any event, Frasch's patent *met with no commercial success.*"[7]

In the present case respondent sought to prove that the Frasch process had been successfully commercialized about the date of the patent by offering some old correspondence under the ancient documents rule and the testimony of a few witnesses who still had a very general hearsay knowledge of the facts. Plaintiff followed with more definite proof of Frasch's actual operations by offering contemporary published articles regarding the few treatments made with the Frasch process.

This evidence shows that the Frasch process was tried under the supervision of Van Dyke on sixteen wells producing from Trenton limestone near Lima, Ohio, during 1895-97. Two producing wells were not increased at all, two dry holes were not benefited, and in only two of the other twelve wells was there a sufficient increase to justify the expense of the treatments. A careful study of the data on the fourteen producing wells shows that the process increased production *immediately* after the treatments by an average of 11½ barrels a day per well, which was insignificant compared with the cost of the treatments. How long these small increases held up does not appear.

Based on this new evidence, the lower courts in this case called the Frasch operations a commercial success, apparently because some of the treatments somewhat increased production. The Circuit Court of Appeals particularly stressed percentage figures, referring to one well

[7] All emphasis in quotations is added unless otherwise indicated.

as showing a 300% increase, whereas the flow was actually increased only from one barrel to four barrels a day.[8] This was the first well treated and was owned by the Ohio Oil Company, which discontinued the use of the process after three more of its wells were treated.[9]

Thus, whatever merit the Frasch process actually had was thoroughly known to very eminent oil men who had the ability and the opportunity to extend its use had it been considered a commercial success. Yet, the Ohio Oil Company dropped the process after four treatments and further use of it was completely, totally and finally abandoned after a dozen other scattered treatments. No effort to increase the production of wells by the introduction of any kind of acid into the producing formation was ever again attempted until the Grebe-Sanford process was successfully applied to Michigan oil wells more than a third of a century later.

The striking contrast between the Frasch failure and the brilliant and spontaneous success of the Grebe-Sanford process cannot help challenging the interest of this court, particularly in view of the conclusion reached by the lower courts that the two processes are substantially the same. Although the record does not clearly show why the Frasch process was abandoned, it does show conclusively that the process was a commercial failure. Possible contributing causes were:

(8) This reference was to the Crosley well, treated in August, 1895. (R. 1653, 1894.)

(9) One on the J. W. Taylor farm, treated prior to November 7, 1895, with an apparent increase from 5 to 35 barrels a day (R. 1657); one on the Mary Richard farm, treated prior to January 15, 1896, with an increase from 4 to 11 barrels a day (R. 1658), and one on the Thos. Cusac farm, treated prior to January 15, 1896, with no increase. (R. 1658.) Before the treatment the Taylor well was flowing at the rate of five barrels a day and after the treatment it had to be pumped, and therefore the actual results of the treatment are not known. (R. 1897, 1899.)

1. The cumbersomeness and impracticability of the manipulative steps.[10] According to Frasch's patent (R. 1936) the ordinary pump tube is to be removed from the well along with the pump and pump rod. This naturally requires that these parts be unscrewed into their constituent 20-foot sections and removed section by section. An acid supply pipe, which is to be lined with lead, rubber or enamel and similarly coated outside near its lower end, is then put together section by section and run into the well. This pipe carries a packer near its lower end by which the lower part of the well hole is supposed to be sealed off from the cased part of the well. Concentrated hydrochloric acid is then run down this pipe, followed by water to force it out into the formation, where it is supposed to attack and enlarge the pores.[11] After allowing the acid time enough to work, an alkali is to be forced down to neutralize any unspent acid, the acid supply pipe is removed, being necessarily broken into its constituent sections, the pump tube and pump rod are replaced section by section and pumping is begun or resumed.

2. A second reason why the process failed commercially no doubt was the use of concentrated hydrochloric acid. The Frasch patent recommends the use of from 1,000 to 2,000 gallons of acid containing "from thirty to forty per cent by weight of the acid gas HCl * * *." (R. 1936.) In the first treatment, made in August, 1895, to the Crosley well of the Ohio Oil Company, 65 barrels (2730 gallons) of concentrated acid were used. A letter from Frasch to Van Dyke, written about six weeks after that treatment, indicates that the acid used contained 27% or 28% HCl. The letter further shows that Frasch was seeking a still stronger acid. (R. 1889.) As previously stated, the preferred con-

(10) On this ground alone the Tenth Circuit Court of Appeals held the Frasch process to be commercially impracticable.

(11) That the acid probably did not so act see *infra*, pp. 33, 34.

centration of acid in the Grebe-Sanford process is 15% and that is what petitioner's licensees and respondent use in practice. The differences in the effect of concentrated and dilute acid solutions when used in oil wells are two-fold:

(a) Hydrochloric acid of the concentrations recommended and used by Frasch corrodes iron and steel five times faster than does 15% acid, thus causing greater damage to the equipment with which the acid comes in contact.[12] In the attempts made by Frasch and Van Dyke to commercialize the process the operator requested a new string of acid supply pipe after only four or five treatments in spite of the protective coating inside the pipe. (R. 1890.)

(b) Concentrated acid is more viscous than dilute acid[13] and reacts more violently with limestone. Consequently, it enters the small rock pores more slowly and expends itself on the walls of the well hole and the rock closely adjacent thereto. The resulting spent acid solution is a viscous concentrated calcium chloride brine[14] which must be forced out into the formation ahead of the incoming acid before fresh acid can enter and enlarge the pores.

---

(12) See Charts, R. 1802, 1842-45.

(13) The viscosity of hydrochloric acid solutions is given in the International Critical Tables of Numerical Data, Physics, Chemistry, and Technology published for the National Research Council by the McGraw-Hill Book Co., Inc., New York, New York, 1929, Vol. 5, page 12. For 5 formula weights of HCl per 1000 g. of water, a concentration corresponding to 15.4% HCl, the viscosity relative to water is 1.294 and for 11 formula weights of HCl per 1000 g. of water, a concentration corresponding to 28.6% HCl, the viscosity relative to water is 1.71. Thus 28.6% HCl is about 32% more viscous than 15.4% acid.

(14) The viscosity of the 19.8% calcium chloride brine, which results from spending 14.5% HCl on limestone, is given as 2.56 centipoises at 10° C. on page 105 of the Refrigerating Data Book, published 1942 by The American Society of Refrigerating Engineers, New York, N. Y. The viscosity of pure water at the same temperature is 1.3077 centipoises (page 1676, 24th Edition Handbook of Chemistry and Physics, published by Chemical Rubber Publishing Co., Cleveland, Ohio). The viscosity of the 34% calcium chloride brine which results from spending 27% HCl on limestone is given in the same data book as 8.164 centipoises at 10° C. Therefore, the spent solution from 27% HCl is more than three times as viscous as the spent solution produced from 14.5% HCl.

There the spent acid hinders the flow of oil to the well following the treatment.

3. Finally is the matter of financial return, which no doubt was uppermost in the minds of the well owners. The Ohio Oil Company was not satisfied with the gains from the first two wells treated. After three months operations there had been a gain of only $1200.00 in oil against an expense of over $1500.00 in connection with the two treatments. (R. 1897-99.) These figures included the increased yield from 5 to 35 barrels a day which resulted from pumping the Taylor well after the treatment.[14a] The third well treated for the Ohio Oil Company showed an increase of only seven barrels a day and the fourth well was not benefited at all by the treatment, whereupon the process was dropped insofar as that company was concerned.

Other possible explanations for the abandonment of the Frasch process will be referred to under the heading "Argument," but whatever the reason the fact remains that the process was a commercial failure and was so recognized by The Ohio Oil Company as well as by its promoters, Frasch and Van Dyke. (*Infra*, pp. 30, 31.) That the process did not fail because of lack of pressure appears from the report of the first treatment which shows a rock pressure of 400 or 500 pounds per square inch and a hydrostatic pressure of from 700 to 800 pounds on the acid column. (R. 1653.)

Frasch and Grebe-Sanford Results Contrasted

Frasch's fourteen treatments to producing wells showed a total initial gain of only 161 barrels, of which nearly one-half was in two wells, 30 barrels in one well and 43 barrels in another. The other twelve wells showed an

---

(14a) See footnote 9.

average initial gain of only 7.2 barrels per day, at the expense of very large amounts of concentrated acid.[15]

In marked contrast with the results obtained from these Frasch experiments are those obtained from treatments by the Grebe-Sanford process. The first treatment was inconclusive,[16] but the second treatment resulted in an increase from 30 to about 125 barrels a day, and the third treatment resulted in an increase from 90 barrels to 790 barrels a day. (R. 1018-19.)

This third Grebe-Sanford treatment added several times more oil production than did all of Frasch's treatments combined. From that time on the process met with overwhelming success. With no effort on the part of petitioner to push the adoption of the process, it swept the industry like wildfire within a few months after it was first introduced. Hundreds of letters of inquiry came in from oil companies all over the country, a small part of which are in evidence as Plaintiff's Exhibit 13. (R. 1597-1625.) Petitioner's principal licensee, Dowell, Inc., had employed the Grebe-Sanford process to treat more than 25,000 wells up to the end of 1940. (R. 1806.) The use of this process has added millions of barrels to our oil production and millions of dollars in income to oil producers, not to mention the tremendous increases in the production of fuel gas which have resulted from its use. (R. 191, 1796, Ex. 328.)

While it is impossible in many cases to give comparative figures, they are given for a considerable number of individual wells and also for groups of wells and show that the results of the Grebe-Sanford process were consistently

---

(15) 65 barrels (2730 gals.) of concentrated acid were used in the first Frasch treatment, 108 carboys (1080 gals.) in the second and apparently a large carload in each subsequent treatment. (R. 1651, 1658, 1903-4.)

(16) In the first Grebe-Sanford treatment the acid charge was divided into four 125-gallon shots with the probable result that the acid spent the greater part of its strength on and near the walls of the well hole and did not penetrate the formation sufficiently to materially increase production. (R. 1795.)

successful to a degree never approached by anything obtained from the Frasch process. Taking a few more Grebe and Sanford treatments whose initial gains are shown, we find the following: One well with an initial production of 125 barrels was increased to 1070 barrels a day initially, and after five days was producing better than 500 barrels a day. Another well which when new showed an initial production of 210 barrels a day was increased to 1700 barrels a day, and a third well which had been plugged and abandoned as dry several months before the treatment flowed 358 barrels of oil in 22 hours after the treatment, made 200 barrels the second 24 hours and continued to *flow* at from 100 to 175 barrels per day. (R. 149.)

Taking other treatments as they come in the record, we find an average gain of 20 barrels per well per day from 30 wells *over a period of one year,* despite conservation restrictions (R. 216), and an average gain of 23 barrels per day from 125 wells. (R. 219.) At page 222 is a table showing *average* daily gains of 106 barrels, 38 barrels, 60 barrels, 46 barrels, 75 barrels, 84 barrels, 55 barrels and 43 barrels from a group of eight wells. Two other wells showed initial gains of 650 barrels and 190 barrels per day, respectively (R. 231, 233), and the average initial gains in 41 wells examined as a group was 69 barrels per day and of ten other wells was 170 barrels per day. (R. 233.)

The Operations of Oil Makers Company and Chemical Process Company

Shortly after the success of the Grebe-Sanford process was demonstrated in an oil field near the Dow plant a concern known as the Oil Makers Company began to acidize wells in that and other Michigan fields. Testimony regarding this operation is utterly immaterial on the issue of validity. It was not prior art, nor was it such a reproduction

of the Frasch process as to prove that it could have been revived and made successful. Yet the Court of Appeals treated it as though it were the Frasch process, which it plainly was not. It was a wholly different process developed in the light of Grebe and Sanford's success, and employing two of the three new features of the Grebe and Sanford process, *viz.*, the use of dilute acid and the introduction of the acid through the pump tube. In the first of these treatments dilute (15%) raw acid was used, but this did so much damage to tubing and other well equipment that inhibited acid was adopted and used in the greater part of the treatments.

Concentrated hydrochloric acid, depending upon the exact degree of concentration, is from 2½ to 5½ times as corrosive to mild steel as was the 15% acid used by Oil Makers Company. If Frasch's concentrated acid had been employed it would have been absolutely impracticable for Oil Makers Company to introduce it through the pump tube, and had it done so there is nothing in the record to support an assumption that it would have had any better success in increasing yield than did Frasch. So far as the record shows, nobody has ever attempted doing such a thing as a regular practice.(17)

Because of its highly corrosive character, it would be impossible to apply pressure to concentrated acid by any normal means, such as a pump. Furthermore, the introduction of concentrated acid into a well hole would institute a vicious circle which would interfere with and effectively prevent the accomplishment of the result which Frasch had in mind, *viz.*, the enlargement of the rock pores

(17) In one operation the owner of a well used 100 gallons of raw hydrochloric acid. The language indicates that this was poured into the tubing, in which case it no doubt was concentrated acid, poured out of carboys. As a result of the use of even this small amount of acid, the tubing was destroyed so that later on inhibited acid could not be pumped through it under pressure, and new tubing had to be supplied. (R. 232.)

at a distance from the well hole so as to provide a freer flow of oil to the well. To start with, concentrated acid is more viscous than dilute acid and, therefore, it would penetrate the rock more slowly under equal pressures. Next, concentrated acid reacts more violently with limestone than does dilute acid and as this reaction proceeds the resulting solution becomes more and more viscous through the formation of calcium chloride which is taken up by the solution. Therefore, if concentrated acid were used it would expend much of its strength on the walls of the well hole and the immediately surrounding rock and the resulting viscous solution of spent acid would have to be forced back into the pores ahead of the unspent acid before those pores could be attacked and enlarged. Finally, this viscous spent acid solution would have to be forced out of the pores by the natural rock pressure before oil could pass through them and into the well. The poor results obtained from the Frasch experimental treatments indicate that this is what actually occurred and that the large quantities of concentrated acid used in the Frasch experiments did nothing more than to enlarge the well hole and the pores of the rock immediately surrounding it and to leave the smaller pores clogged with spent acid solution where it obstructed the flow of oil to the well.

Using the comparatively innocuous and free-flowing uninhibited 15% acid, the Oil Makers Company naturally got some satisfactory increases in production without immediately apparent damage to well equipment, but the acid was sufficiently damaging to the tubing that a considerable number of complaints and claims for damages resulted. So much trouble was caused that the Oil Makers Company soon

shifted to the use of dilute inhibited acid, after which their process became a clear infringement.[18] This shift took place almost simultaneously with the issue of the patent in suit, and in the face of that patent and the low price of oil their business faded away. (R. 1238.)

Oil Makers Company made 26 acid treatments with 15% uninhibited acid before they shifted to the directly infringing method and thereafter made a much larger number of treatments with inhibited acid.[19] In these 26 operations, there was definite and ascertainable damage to the equipment in about half the wells. The man who made those treatments quit working for Oil Makers because of this damage. He testified (R. 1271):

> "***We were causing more damage than we were making money to pay for. I also told them (his associates) that unless we found some way to use the acid without causing so much trouble to the steel material in the well, that it was useless to continue to use it."

Chemical Process Company started in business in Texas in the fall of 1932, following the practice of the Oil Makers Company with which it was familiar. It used dilute acid in all its treatments and admittedly used an inhibitor in some of them. It claims to have used only raw acid after the Grebe-Sanford patent was sustained in

[18] Complaints were made on the following wells treated by Oil Makers in July and August of 1932, before any inhibited acid was used. Wells and Malclom's Hastings No. 1 (R. 1259); Stork Oil Co.'s Coon No. 4 (R. 1263); G-Lee-P Co.'s Schaeffer No. 1 (R. 1263,4); McClanahan Co.'s Schaeffer No. 1 and Struble No. 2 (R. 1269); Schuller's Reimenschneider No. 1 (R. 1267, 8), and Gordon Oil Co.'s Tanker No. 1 (R. 1269). In addition, cash settlements for damage or free treatments in settlement for damage claims were made with Gordon Oil Co. (R. 1203-9), Moline Investment Co. (R. 1204), Stork Oil Co. (R. 1204, 10, 11), Malcolm and Stork (R. 1205-6), Malcolm Oil Co.—3 weils—(R. 1206, 7, 12), G-Lee-P Co.—2 wells—(R. 1207, 12), Columbia Oil & Gas Co. (R. 1211) and Cliff Warner—2 wells—(R. 1211).

[19] A total of about 250 wells were treated. (R. 1195.) Proven purchases of acid were: Raw acid $1,220.80 (R. 1196-7); inhibited acid $4,145.71 (R. 1199-1200).

the *Williams* case (R. 1004), but this claim is supported only by the testimony of one interested witness, the vice president of the company, and is in conflict with the testimony of another witness who investigated the operations of that company in 1939 and found rolls of sheet lead in its acid delivery tanks, similar to those contained in respondent's tanks. The unavoidable effect of the presence of sheet lead in the acid delivery tanks is the development of inhibitors (copper and lead chlorides) in the acid before it is introduced into the pump tube. (R. 1302-6.) These are the identical inhibitors that were present in respondent's acid in the process which both lower courts held to infringe. As in the case of the Oil Makers Company, these operations were neither prior art nor the Frasch process.

The Gypsy Oil Company's Scale Removal Experiment

This brings us to the attempt of Gypsy Oil Company in 1928-29 to remove calcium carbonate scale (called gyp) from the tubing in some of its sandstone wells by the use of concentrated hydrochloric acid. The Tenth Circuit Court of Appeals considered this alleged prior use on substantially the same evidence as that here present and held, first, that it showed nothing more than an unsuccessful and abandoned experiment, and, secondly, that it would not have anticipated even if fully established as a prior use. The courts here held it to be a successful prior use *anticipating* the patent in suit.

In the instant case, a little additional testimony was taken, but it added nothing to the facts, and certainly nothing that was not fully admitted in the Tenth Circuit. The only reliable evidence of the Gypsy experiment is that contained in contemporaneous written recommendations, reports and correspondence, and this evidence is identical in

both records. In addition, the depositions of Case, Wright, Kiser and Knappen in the Williams case were stipulated into this record.

The two courts simply differ in their legal interpretation of facts which are clearly proved by evidence stipulated into this case from the earlier one. The Court of Appeals in this case refers to testimony by Dr. Wescott which was not before the Tenth Circuit.[20] The part alluded to is his statement that the use of inhibitors to protect metal from attack by hydrochloric acid was well known at the date of the Gypsy experiment. (R. 2057.) This was openly and frankly conceded at all times in the Tenth Circuit. Indeed, we not only conceded but we stressed the fact that although inhibitors were very well known and in active use right under the eyes of many oil producers, they never thought of using them for the purpose for which Grebe-Sanford employed them.[21]

The Gypsy Oil Company in 1928, was producing oil from *sandstone* in the Glenpool field in Oklahoma, and was having trouble from the formation of a lime deposit, called "gyp," on the pump tubing, valves and casing. (R. 1665.) The usual way of coping with the problem was to withdraw the tubing from time to time and clean it mechanically. The company wanted to avoid this inconvenience, and to clean the tubing while in place. To this end, it referred the problem to the Mellon Institute, whose conclusions and recommendation were embodied in a formal report by Dr. Wescott. This is printed in both records but it was *not a public record* at the date of the Grebe-Sanford invention. (DX-151, R. 1908.)

[20] The only additional evidence here is a second deposition by Knappen and a deposition of the chemist Dr. Wescott who recommended the scale removal treatment in question. Neither of them witnessed any of the treatments relied on to establish this prior use and both frankly admit that they secured their information from the reports and correspondence, which are identical in both records. In his new deposition, taken in 1941, Knappen said his memory of events was better in 1934, when he gave his first deposition. (R. 1086-7, 1091, 1102, 1111-13.)

[21] In his deposition in the *Williams* case defendant's witness Knappen testified that his company had used inhibited hydrochloric acid from 1920 on for the removal of calcium carbonate scale from the cylinder blocks of engines. (R. 1078.)

The report discussed at length the formation of scale and its composition and concluded by recommending that an attempt be made *in one well* to dissolve the scale by the use of inhibited concentrated hydrochloric acid. (R. 1921.) The report stated that while many inhibitors were satisfactory with *dilute* acid, special tests had been made with concentrated acid and that a commercial inhibitor known as Rodine should be used with such acid.

For the removal of the Gypsy scale this recommendation of concentrated acid was doubtless sound. The scale formed a thick deposit on the surface of the well casing and tubing (R. 1910) and a weaker acid would have been neutralized before it had eaten through the scale. However, it was recognized that the acid might attack the producing sandstone formation, dissolve the binder and free a large amount of sand, which would fall into the well hole. What was desired was a vigorous reaction on the scale, and the record shows that the operators took great precautions to prevent the acid from getting into the rock. (R. 1682.) It was recommended that the acid be permitted to "trickle down the casing and be immediately pumped out through the tubing." (R. 1681.)

The first Gypsy test was made on November 12, 1928, on Berryhill No. 8 well and resulted in the pump being choked with sand as had been feared, so that it was "necessary to pull the pump several times in order to get the well to pumping normally." (R. 1683.) This test was fully reported, and it is the only one of the tests relied on to prove this experiment concerning which there is anything but oral testimony. One report states: "The first experi-

ment with the acid has been run at Glenpool with unsatisfactory results." (R. 1683.) A further discussion of the same test states: "The treatment has apparently not benefited the well production." (R. 1684.) A further report states: "The production of the well, however, has not increased. * * * However, it is doubtful if production can be increased." (R. 1686.) A later letter states "No improvement in oil production has been shown." (R. 1687.)

Following this first test the Gypsy Company, in 1929, is said to have treated six additional wells with acid to remove scale. In two of them the inhibitor Rodine is said to have been employed as in the first test. In three of them acid is said to have been used without an inhibitor. In one of them a material of utterly unknown composition, known as Armine, was used. There are no written reports of these treatments and they were testified to by only one witness, Kiser, whose testimony in the Tenth Circuit was copied into this record. (R. 1075-77.) Gypsy is said to have made two more of these treatments, in neither of which was an inhibitor used. (R. 1075-6.) One is said to have been made in 1930 and the last one on March 10, 1931. (R. 1075-6.)

Thus, there is some evidence regarding ten different tests, but we have a good description of only the first one. The record is silent as to the steps followed in the other nine and as to the results obtained. In only three of the ten is it claimed that an inhibtor was used. In some it is said that no inhibitor was used, and as to some we have no information. These tests were reported to be unsatisfactory, the whole scheme was dropped, and other experiments along different lines were undertaken.

In the summer of 1931, an experiment of a different kind was carried out on the Anderson No. 3 well, in an effort to prevent scale formation, rather than to remove it. In this operation, also approved by the Mellon Institute

(R. 1691), the acid was slowly and continuously lubricated in to the casing over a considerable period of time. As demonstrating the uncertainty of operations far underground, this test increased rather than diminished scale. (R. 1690.)

Finally, in October, 1931, a test was made to remove the scale with a mechanical scraper, which was sufficiently successful that its use in other wells was recommended. (R. 1693.) That the gyp problem was not considered solved by the experiment relied on appears from a letter written in July, 1932, which shows that Gypsy was still trying to find a means for preventing its formation. (R. 1698).

During all this period the same Gypsy Oil Company, only a short distance away, was operating limestone wells which would have been enormously benefited by the Grebe-Sanford process. When the success of that process became generally known, Gypsy was one of the first large oil producers to turn to the Grebe-Sanford process to increase the production of its limestone wells.

Subsequent to July, 1931, and until it made use of the Grebe-Sanford process, no well of Gypsy Company was treated for any purpose with acid of any kind, inhibited or uninhibited. When Gypsy learned of the success of the Grebe-Sanford process, its general superintendent promptly wrote to Dowell, Inc., under date of January 19, 1933, inquiring when it would be in a position to treat wells in Gypsy's Kansas area. (R. 1704.) As a result Dowell, Inc., soon commenced applying the Grebe-Sanford process to Gypsy's limestone wells. It made its first treatment for Gypsy on February 10, 1933, and has continued to treat wells for Gypsy up to the present time. Prior to November 10, 1933, Dowell had treated nine other wells for Gypsy and up to the time Knappen testified in the Williams case in 1934 about 75 other Gypsy wells had been similarly treated.

(R. 1088.) Up to 1941 Dowell, Inc., had treated a total of 348 wells for Gypsy Oil Company. (R. 1405.)

SUMMARY OF ARGUMENT

1. New proofs in this record fully establish the soundness of the conclusion of the Tenth Circuit Court of Appeals that the process of Frasch patent 556,669 "was cumbersome and expensive, and probably impracticable * * *." They show that men eminent in the oil industry made a resolute attempt to commercialize that process about the time the patent issued and that the effort was discontinued after thorough trial. The Ohio Oil Company, one of the then largest oil producing companies, tried the process in four of its wells before abandoning it. Thereafter the owners of the patent tried it over a period of eighteen months in a dozen other wells of as many different owners with the result that it was then completely abandoned and never revived. After the lapse of more than a third of a century, during which period the number of limestone fields greatly increased and the need for such a process grew, the invention of the patent in suit was made and became a spontaneous and spectacular success, producing in the third treatment and with only a small fraction of the acid used in the Frasch treatments a greater increase in production than resulted from all the Frasch treatments combined.

Petitioner, having proved beyond any doubt that the Frasch process was a commercial failure, is not charged with proving why it failed. Certainly it was not due to lack of funds or opportunity. Its owners and promoters were eminent men of wide experience and influence in the oil industry and their trial treatments were given extensive publicity. The need for a practicable process for increasing the production of oil from limestone fields existed before the Frasch process was tried, it grew steadily with the

opening of new limestone fields, the means for solving the problem were at all times readily at hand, and yet the solution remained a mystery and the need unsupplied until Grebe and Sanford disclosed their simple solution in 1932.

The failure of the Frasch process can be explained only on the theory that it had inherent defects.

2. The raw acid process used by the Oil Makers Company for a few months, and said but not proven to have been used by Chemical Process Company, was not the Frasch process at all, but a new process which utilized two of the three features which distinguish Grebe and Sanford from Frasch and to the use of which features must be attributed whatever success those companies may have obtained from the use of raw acid as compared with Frasch's dismal failure. Both those companies came into existence after the Grebe-Sanford process had become a recognized success and was being widely used; hence their practices, whatever they were, are not prior art.

The use of raw acid by Oil Makers Company resulted in so much damage to well equipment that at the end of a few months it was obliged to change to the more expensive inhibited acid, thereby becoming a direct infringer of the patent in suit.

The use of uninhibited acid at any time by Chemical Process Company is not established. It is supported only by the uncorroborated testimony of a single interested witness and is opposed by positive uncontroverted proofs, including physical exhibits, that the steel tanks in which that company transports its acid to the wells contain quantities of lead sheets, as do defendant's tanks, the only purpose of which and the inevitable result of which is to produce in the acid the identical inhibitors—lead and copper chlorides—which are used by defendant in its infringing process.

3. There is no factual evidence in this record regarding the Gypsy use of hydrochloric acid in its scale removal

attempts that was not before the Tenth Circuit Court of Appeals when that court held this alleged prior use to be nothing more than an abandoned experiment and in any event not anticipatory, yet the Sixth Circuit Court of Appeals held it to be both a commercial success and an anticipation. All the evidence on this subject in the Tenth Circuit case was stipulated into this record and the only new evidence here is a second deposition by Knappen, taken seven years after he testified in the *Williams* case, and a deposition by Wescott. Each testified that he had not witnessed any of the tests relied on by defendant to establish this prior use and that he depended for his information on the correspondence and written reports, which are identical in both records.

The objects, procedures and results in the Gypsy and Grebe-Sanford processes are entirely different. Gypsy was concerned with the removal of "gyp" deposits from the pump equipment in sandstone wells and endeavored to keep the acid from entering the sandstone formation, whereas the Grebe-Sanford process is designed to enlarge the pores of the producing formation in limestone wells to facilitate the flow of oil to the wells. Gypsy used concentrated acid which was five times as corrosive to mild steel as is the dilute acid used by Grebe-Sanford. Gypsy used only enough concentrated acid to fill the well tubing and the space between the tubing and well casing, and let it stand there long enough to eat its way through the scale. Grebe and Sanford use a large volume of dilute acid which they do not permit to enter the space between the tubing and casing. Gypsy took precautions against passage of the acid into the formation, whereas Grebe and Sanford force the acid through the well tubing and out into the formation as quickly as possible. The Gypsy treatments did not increase the production of oil, whereas the sole object of the process in suit is to increase production.

In only three of the Gypsy experiments was an inhibitor used in the acid. The last Gypsy experiment to remove gyp with *inhibited* acid was in September, 1929, and the last one with *raw* acid was in March, 1931, after which Gypsy tried various other means for removing scale from its wells.

Gypsy learned of the success of the Grebe-Sanford process in January, 1933, and immediately wrote plaintiff's licensee regarding treatments to its wells. It began using the Grebe-Sanford process early in February, 1933, and by the end of 1934 had used that process with marked success in nearly one hundred of its wells.

ARGUMENT

In support of its finding of invalidity the Sixth Circuit Court of Appeals relied on (1) the Frasch patent and a few experimental applications of the process of that patent in 1895-97; (2) acidizing treatments made by Oil Makers Company and Chemical Process Company, subsequent to the introduction of the Grebe-Sanford process, which the court assumed to be a revival of the Frasch process, and (3) the experiments of the Gypsy Oil Company on three wells during 1928 and 1929 for the removal of "gyp" scale from the equipment in sandstone wells by the use of inhibited concentrated hydrochloric acid.

Petitioner contends that the record shows the Frasch process to have been a commercial failure, that the practices of Oil Makers Company and Chemical Process Company were neither the Frasch process nor prior art, and that the operations of Gypsy Oil Company were nothing more than an abandoned experiment which *would not have anticipated even if fully established*.

POINT I. THE FRASCH FAILURE

The following facts regarding Frasch are clearly established by uncontroverted proofs:

(a) The Frasch patent recommends the use of from 1,000 to 2,000 gallons of hydrochloric acid containing from 30% to 40% HCl. In his actual treatments Frasch used from 2,100 to 4,200 gallons (50 to 100 barrels) of raw acid containing 27-28% or more HCl, except in the second treatment where 1080 gallons were used. (R. 1652, 1889.)[22]

(b) The method employed by Frasch for practicing his process was cumbersome and the equipment used was short-lived because of the highly corrosive action of the concentrated acid used.

(c) The average *initial* increase in production that resulted from Frasch's treatments of 14 producing wells was only 11½ barrels per well per day, with no evidence to show how long these increases held up. (R. 1651, 1657-63.)[23]

(d) The Ohio Oil Company discontinued the use of the Frasch process early in 1896, after four of its wells had been treated with an average initial increase of 10 barrels per day, and criticized the expense in comparison with the results obtained from the first two treatments, one of which flowed 5 barrels a day before treatment and pumped only 35 barrels a day after treatment. (R. 1897-99.)

---

[22] Hydrochloric acid is a solution of hydrochloric acid gas—HCl in water. It is most commonly made and shipped in the following strengths:

18° Baume, containing 27.75% HCl.
20° Baume, containing 31.45% HCl.
22° Baume, containing 35.21% HCl.

American Chemical Society monograph 36. Hydrochloric Acid and Sodium Sulfate by N. A. Laury, published by The Chemical Catalog Co., Inc., 1927, pages 17, 27 and 49.

[23] Two of these wells were not helped at all and two dry wells were not benefited. This average includes the 30-barrel increase of the Thomas well of the Ohio Oil Company which was *flowing* at the rate of 5 barrels a day before the Frasch treatment and made only 35 barrels a day when *pumped* after the treatment. (R. 1657, 1897.)

(e) After twelve other treatments to wells owned by as many different parties over a period of about two years the Frasch process was dropped in 1897 and never again used, although the owners, Frasch and Van Dyke, were men of prominence and influence in the oil industry and in position to continue and extend the use of their process had it been a success.

(f) The Frasch treatments were given wide publicity. As long as they were being carried on a series of puffing articles appeared in the Oil City Derrick, the then leading oil journal, indicating that the process was expected to be a great boon to the oil industry; yet suddenly, with no published reasons, the articles stopped and the process passed into the limbo of tested and proven commercial failures. (R. 1651, 1656-63.)

(g) The need for some such process during the thirty-five years that elapsed between the last Frasch treatment and the first Grebe and Sanford treatment was urgent, due to the increase in the number of limestone fields from a few dozen to more than 400 and also to the fear of oil exhaustion during a large part of that period. (R. 28 and PX-192.)

In sharp contrast to these established facts with respect to the Frasch process are the following equally well established facts with respect to the Grebe-Sanford process:

(a) In their early treatments which established the success of the Grebe-Sanford process they used only 500 gallons of 15% acid—from ¼ to 1/12 of the acid ingredient (HCl) used in the Frasch treatments. (R. 1591.)

(b) 27% or 28% HCl solutions, such as used by Frasch, are five times as corrosive to mild steel as is the 15% solution used by Grebe and Sanford[24]

[24] Raw acid of the strength used by Frasch will dissolve 1.38 lbs. of steel per square foot of surface per day, raw 15% acid at the rate of only 0.263 lb. per day. (R. 1802.)

(c) The second and third Grebe-Sanford treatments gave initial increases from 30 to 125 barrels a day and from 90 to 790 barrels a day. (R. 1618-19.)

(d) The Pure Oil Company, which owned the first wells treated by the Grebe-Sanford process, continued to be a large user of the process, more than half of the 250-odd wells treated during the first six months having been owned by that company. (R. 1591-6.)

(e) The results obtained from the Grebe-Sanford process were so outstanding that they soon became known to the oil industry without effort on behalf of petitioner and inquiries came from oil producers all over the country, including many of the largest oil companies. (R. 144-5, 1597-1625.) This necessitated the formation of a separate subsidiary corporation, Dowell Incorporated, and the establishment of treating stations in many states to handle the demand for treatments. (R. 127-8, 1655.)

Why Frasch Was Abandoned

The record does not clearly show why the Frasch process was abandoned, nor is the burden on petitioner to show the reason. Respondent advances the Frasch patent and the use of the Frasch process in a few wells as its main defense, and the burden should be on it to account for the abandonment of that process on some theory other than that it was a commercial failure. This it has not done. But, although we do not have any direct proof on this subject, the record is not wholly devoid of indications as to the cause of the failure of the Frasch process.

1. The concentrated acid used was so intensely corrosive as to compel the costly and cumbersome expedients which Frasch used to get it into the well. (*Supra*, p. 13.) Their efforts to protect the acid supply pipe from this strong acid by lining it throughout and coating the outer

surface of its lower part with an acid-resistant material obviously were failures. After only five treatments one set of acid supply pipe was so badly corroded as to be useless. The rubber manufacturers said they could not provide the rubber protective layer suggested in the patent, and it is almost self-evident that however one might try to line the lengths of pipe, the screw threaded joints could not be protected and would inevitably be destroyed after a little use. Corrosion of the screw threads would create grave danger that the string of pipe would part, and that would require a difficult if not impossible effort to recover the lost part by fishing for it hundreds and even thousands of feet underground. Furthermore, the suggestion that the acid be prevented from rising to the height of the casing by means of a packer was not practicable, as pointed out by the court in the Tenth Circuit.

2. The high concentration of the acid used by Frasch was no doubt responsible for an even more serious defect in that process—*viz.*, the failure to produce increases in production sufficient to justify the expense of the treatments. Concentrated acid reacts with limestone much more quickly and violently than does dilute (15%) acid. Consequently, unless the concentrated acid is to expend itself on the walls of the well hole and the pores of the immediately surrounding rock it should flow with sufficient ease and have enough pressure back of it to force it quickly out into the formation. But several causes inherent in the use of concentrated acid would cooperate to prevent this. In the first place, concentrated acid flows less freely than does dilute acid; in the second place, Frasch had to rely and did in fact rely on the hydrostatic pressure of the column of acid in his one-inch acid supply pipe, because no suitable pump could handle such strong raw acid;[25] in the

[25] The Oil Makers Company ruined a pump in a few treatments with uninhibited acid of but 15% concentration. (R. 1265.)

third place, concentrated acid forms and takes up calcium chloride with much greater rapidity than does dilute acid and the higher the percentage of calcium chloride in the spent acid the more viscous it becomes; and, finally, this spent acid would have to be forced back into the formation ahead of the incoming fresh acid before the latter could reach and attack the pores in the formation away from the well hole. All these conditions would contribute to slow down the movement of the acid back into the formation and thereby tend to defeat the object Frasch sought to accomplish.

3. Another possible explanation of the unsatisfactory increases that resulted from the Frasch treatments was the difficulty of removing this viscous spent acid from the pores of the rock. It had to be forced out ahead of the oil by the natural rock pressure and to the extent that this spent acid remained in the pores the flow of oil to the well hole was blocked or lessened.[26]

In the light of the foregoing, it is not strange that the Frasch process was abandoned. While technically operative to clean the walls of a well hole and open the pores at that point, it was not capable of successfully carrying out Frasch's object of enlarging the pores of the rock "at a distance from the original well hole."

So far as teaching the industry anything, this old patent, the experimental treatments thereunder and the publicity given to them were worse than useless.[27] In

(26) That concentrated HCl is more viscous than dilute HCl and that the brine resulting from the reaction of concentrated HCl on limestone is much more viscous than was the unspent acid are well known facts of chemistry, and that Frasch relied on the hydrostatic head of his column of acid to force the acid back into the formation clearly appears from the Frasch patent and the reports of the Frasch operations. (See footnotes 13 and 14, and *infra*, p. 41.)

(27) That these treatments were considered to be experimental by those connected with them clearly appears. They are so referred to in the published articles and in the Ohio Oil Company correspondence. (R. 1656, 1657, 1659, 1896 and 1897.)

their absence others might have tried acid treatments and eventually have been successful. But when Frasch and Van Dyke, who knew all about the patent and the efforts to commercialize the process, deliberately and permanently abandoned all efforts at any kind of acidizing, their standings in the chemical and oil industries were such as to discourage any later attempts. Surely Frasch and Van Dyke would not have discarded an open sesame to untold wealth unless there was some "bug" in the scheme which defeated its purpose. With the best of chemical and petroleum technical skill at their command and with unlimited opportunities for making experiments, they would have eliminated the "bugs" if they could have been eliminated as easily as the lower courts assumed. The practical failure of the Frasch process, when tried by such eminent men as Frasch and Van Dyke, and the publicity given their experiments, undoubtedly served to deter others from attempting to increase oil production by acidizing the formation.

The tremendous difference in the over-all results from the Frasch and Grebe-Sanford processes demonstrates that they are not the same or even closely similar and refutes the soundness of the conclusion reached by the courts below that Grebe and Sanford merely revived the old Frasch process with the addition of some slight changes of trifling importance which added somewhat to convenience and cheapness of operation but which should have been obvious to anyone skilled in the art.

This theory simply cannot be true. Had the Frasch process possessed the elements of success it would have succeeded commercially with the backing it had. If the tests made had not convinced its promoters of its impracticability, or if the means of avoiding the defects had been so apparent as the lower courts assumed, they surely would have given it further trials.

The two processes must, therefore, be carefully compared to see what the differences are which could make one a commercial failure and the other a spectacular commercial success. In considering this, we must always remember that the oil producer is interested in absolute increases of his yield in barrels.

The Grebe-Sanford process in its preferred form, as covered by claim 8, differs from the Frasch process in three respects:

First, Frasch in his patent taught the use of commercial concentrated hydrochloric acid containing from 30% to 40% HCl, and actually used in his first treatment acid containing from 27% to 28% HCl, whereas Grebe and Sanford in their patent taught the use of hydrochloric acid containing only 5% to 20% HCl and actually used 15% HCl. This dilution alone substantially reduced the viscosity of the acid, greatly slowed its reaction on limestone, thus allowing the acid to open up channels distant from the well hole, and greatly reduced its corrosive action on iron and steel. (R. 1802.)

Second, positively to insure the acid against damaging corrosive action on iron and steel, Grebe and Sanford added to it an inhibitor which quite effectively prevented attack by the acid on the metal equipment of the well without interfering with its intended action on the rock. Such inhibitors were well known to chemists long before Frasch's work, and have been constantly used ever since. But Frasch and his associates never thought of using them, and nobody else prior to Grebe and Sanford ever again tried to increase the production of a well by treating the producing formation with acid, either raw or inhibited.

Third, having thus rendered their acid innocuous, Grebe and Sanford introduced it through the ordinary pump tube already in the well, and thus eliminated the costly, cumbersome and, as found in practice, ineffective method of introducing it through a specially protected acid supply pipe. Not only was Frasch's pipe impracticable because it could not be made proof against attack by the acid at the joints, but it was far too small to hold the acid charge, thus making it practically impossible to apply pressure other than that resulting from the weight of the acid column. No suitable pump then or now known could be used to pump concentrated acid.

Fourth, although Frasch's concentrated acid reacted much faster with the rock and so should have been forced in much faster to prevent its spending most of its strength enlarging the well hole and the pores close to the hole, inherently it went in much more slowly under comparable conditions. Concentrated acid being about one-third more viscous than the dilute acid of Grebe and Sanford, under equal pressures will flow only at about two-thirds of the speed of their dilute acid.

While Frasch's patent suggests (R. 1936, ls. 38-9) that other pressure means may be used, Frasch *actually* relied entirely on the hydrostatic head of his acid in the supply pipe to get the bulk of it into the rock. In his experiments, having pulled the pump tubing and inserted his one-inch diameter acid pipe, he had a tube which in a well of the depth in the Lima field (about 1200 feet) would hold only about one barrel of acid.[28] At the top of his acid pipe Frasch shows a funnel-shaped box. Assuming this to be kept full of acid, only the weight of the full column would press the acid out into the rock. Frasch's acid, therefore, entered the rock only as fast as the head of acid would drive it, and this rate was necessarily quite slow.[29] The

(28) According to accepted engineering tables the capacity of a one-inch pipe is 0.0408 gallons per foot of length.

(29) Defendant's Exhibit 105 (R. 1894) states that the treatment to the Crossley well of the Ohio Oil Company was begun on August 5th and finished on August 10, 1895.

Frasch correspondence speaks of dumping the acid (R. 1885 and 1887) and of pouring the acid (R. 1891, both expressions consistent only with the use of a gravity head produced by the flowing column of acid in the supply pipe. The latter of these letters, from the operator to Van Dyke, states that permission had been obtained to use a pump on the premises "to pump the oil and water with," but never is there mention of pumping the acid.

Acid neutralizes itself quite quickly in the fine pores of limestone, which present enormous surfaces to be acted upon. It is usually spent in an hour or less and the record shows one case where it was proved to be spent in 20 minutes. (R. 203; see also R. 284.) Hence, acid introduced slowly, as in the Frasch experiments, would spend itself close to the well hole and the acid which follows would drive the still more viscous spent acid ahead of it while further enlarging the well bore and closely adjacent pores. At the end of his operations Frasch followed his acid with water under pressure, but the only acid this could have driven out into the rock was the viscous spent acid already there and in the well hole and a small quantity of fresh acid, about one barrel, held in the acid pipe.

The Grebe and Sanford procedure is radically different, aside from the fact that their fresh as well as spent acid is less viscous and flows easier. In their earlier operations and many of the later ones, the pump tube took the entire charge of acid,[30] but this is of minor importance in the Grebe-Sanford process because the dilute inhibited acid used can be and commonly is pumped into the well tubing. (R. 265, 287.) As soon as all of the acid has entered the pump tube, whether it is poured in or pumped, oil is pumped under heavy pressure down the tubing behind the acid (R. 1502, lines 78-82 and R. 287), driving it compara-

[30] A three-inch pump tube holds 0.3672 gallons per foot of length, and a two-inch tube 0.1632 gallons.

tively quickly out into the fine pores before it has time to spend its strength on the rock in and near the bore.

Briefly, the concentrated acid Frasch introduced slowly reacted quickly with limestone, whereas to enlarge the pores away from the well it should flow in especially fast. Yet, because of the inherent nature of the Frasch operation, the acid actually must enter the rock comparatively slowly. Grebe and Sanford, using a freer flowing but slower acting inhibited acid, can and do drive it in comparatively rapidly.

The record, of course, shows that wells differ in the permeability of the rock and even with high pressure the introduction of the acid varies over a wide range. Speed of introduction is always advantageous, and, in the same kind of rock Grebe and Sanford can always get a far quicker dispersion of the acid than Frasch could possibly have attained in the same formation.

Due to the differences above enumerated the Grebe-Sanford process brought practical success and wide adoption, whereas the Frasch process proved to be a failure not only commercially, but as a method of increasing production. Examination of the actual operations demonstrates an enormous difference in results, which in turn shows beyond a doubt radical differences between the two processes.

In setting up a prior process as an anticipation or as prior art to negative invention the burden is heavily on the party advancing it to prove similarity. The court should not be required to speculate as to the reason for such striking differences in results as exist between these two processes, which operate far below ground where nobody can see what happens. Respondent must prove substantial identity. (*Radio Corporation vs. Radio Engineering Laboratories*, 293 U. S. 1, 7, 8.) This it has signally failed

to do. The results, on the contrary, demonstrate the existence of important differences in underground operations.

Frasch actually used from two to eight times the volume of HCl that Grebe and Sanford used. Viewed economically, Frasch's acid, gallon for gallon, contained twice as much HCl as that of Grebe and Sanford and would cost twice as much, and his total charge of acid would cost from four to twelve or more times as much as the charges used by Grebe and Sanford in their early treatments when the success of their process was demonstrated, entirely aside from the saving effected by reason of their simple mode of introducing the acid.

Yet, Frasch's results were miserably poor. His first well, treated with 2,720 gallons of concentrated acid, showed a gain of only three barrels a day. His second treatment, with 1,080 gallons of concentrated acid converted a well which was flowing at the rate of 5 barrels a day into one which had to be pumped after the treatment and gave an initial production of only 35 barrels a day. This was one of his two best tests. Frasch's third treatment (with a carload of concentrated acid, actual amount unknown, but probably near Frasch's upper limit of 4,000 gallons) produced an initial gain of only 7 barrels a day. The third treatment with the Grebe-Sanford process, with but a small fraction of the bulk of acid Frasch used and a still smaller fraction of active acid (500 gallons of 15% acid), produced an initial gain of 700 barrels a day. This and other early successes of the Grebe-Sanford process naturally led to overwhelming commercial approval and adoption.

The record does not show the initial gain in most of the individual wells treated by the Grebe-Sanford process. Most of the evidence was directed to the over-all gain in oil production, number of wells treated, long time gains in various wells and fields, etc. In an acidized well as in a new

well production gradually falls off, and since there are no long time production figures on the Frasch treated wells, we cannot compare with them.(31) Furthermore, average gains of wells treated by petitioner's process do not indicate the full gain because conservation laws have often held down production below obtainable maxima.

The only possible comparisons are between the initial gains which Frasch made and initial gains made by such Grebe and Sanford operations as happen to be shown at various places in the record. Frasch made 16 treatments, of which two were dry holes which remained dry after treatment. These two are omitted to give a fair picture. Of the fourteen other treatments, three have already been considered, leaving eleven more treatments the initial per diem gain from which were as follows, in the order of the dates of their published descriptions: 0 barrels, 5 barrels, 8.5 barrels, 9 to 12 barrels, 0 barrels, 10 barrels, 12.5 barrels, 13.5 barrels, 43 barrels,(32) 12.33 barrels and 3 barrels. The average initial gain of the fourteen treatments was 11.5 barrels a day, with no evidence to show how long this gain was sustained. Some of the initial gains that resulted from the use of the Grebe-Sanford process are set forth at pages 16 and 17, *supra*.

Inhibited acid presumably attacks limestone the same as does raw acid and we have always conceded this. Therefore, the difference in results must lie largely or wholly in the relative concentration of the acid and the manner of its introduction. Frasch used far more acid than did

---

(31) The trade journal article which states that the gain of 3 barrels a day in the first well was permanent was written only two months after the treatment, so nobody knows how permanent it was. (R. 1653-4.) This is in no way comparable with average proven gains over five years from the Grebe-Sanford process.

(32) This well before treatment rapidly fell off from 60 barrels to 2 barrels production, doubtless indicating that the pores in the rock close to the well hole were plugged up. The acid opened these pores and produced a big change. This is an unusual condition, but of course the gain is figured in the above average. (R. 1662.)

Grebe and Sanford, so that one would naturally expect his increases in yield to have been greater than theirs. Yet his gains were far less. The only reasonable conclusion to draw is that the raw concentrated acid which Frasch used did much less useful work than the dilute inhibited acid used by Grebe and Sanford.

To attempt to account definitely for the failure of the Frasch raw concentrated acid process and the success of the Grebe-Sanford process would be largely speculation. The operations occur far underground, beyond the sight of man and under pressures of several hundred pounds per square inch. The results show there is a difference. Frasch used a violently reactive acid which he introduced slowly, so that most of its work was necessarily in or near the well hole. Grebe and Sanford used acid which because of its dilution acted on the rock comparatively slowly, and because it was inhibited and harmless to metal they could and did force it through the regular well tubing far into the rock comparatively fast, so that it did a large amount of its work at a distance from the well hole. Perhaps this explains the difference. In any event, the ultimate fact is clear—the Frasch concentrated raw acid process was a complete commercial failure, while the Grebe and Sanford dilute acid process was a brilliant success.

We may well wonder why Frasch and Van Dyke did not use an inhibitor and the regular pump tubing, and thus rid themselves of a major difficulty in making their treatments. However, the history of technical development very often shows that the ablest men sometimes overlook means of which they might easily have availed themselves had they happened to think of them. Furthermore, there is nothing in the record to warrant an assumption that Frasch's results in increased yields would have been benefited by the use of an inhibitor in the concentrated acid used in his experiments. Frasch's over-all results were

so poor as not to encourage anyone to revive his abandoned scheme. Despite its vastly increased convenience and simplicity of treatment, due to the use of dilute inhibited acid, the Grebe and Sanford process might have failed commercially had its results been as poor as Frasch's and as costly in acid.

From this standpoint, even an average of initial gains is deceptive, because business men are not willing to gamble on the mere possibility of success from an expensive operation. Taking the least successful half of Frasch's 14 tests on producing wells, we find the initial per diem gains ran 0, 0, 3, 3, 5, 7 and 8½, or an average of about 3.8 barrels. Considering the very large amount of concentrated acid Frasch used, those seven operations were undoubtedly losing ventures. When a process is so uncertain that half its operations result in losses, commercial success is out of the question, certainly unless the other half of the operations show such large and abundantly compensating advantages as to excite the gambling instinct.

Again let us consider the results obtained for one customer, The Ohio Oil Company, four of whose wells were treated. As previously explained, one of its wells pumped 35 barrels after the treatment, whereas it flowed 5 barrels before. The other three gained 3, 7 and 0 barrels respectively, average 3½ barrels. Even giving Frasch credit for the 30-barrel gain, no oil producer would go further with a process which in three out of four tests gave such poor results at such high cost. If the results obtained in Frasch's two best wells could have been dependably duplicated, his process might have succeeded, but even those results were insignificant compared to the increases which Grebe and Sanford obtained in their very early work.

It cannot be asserted with reason that it would pay to revive the Frasch concentrated acid process as he used it. Nobody has again tried it, and since respondent contends

this is an anticipating process it certainly ought to have produced evidence tending to show that such a process could have succeeded.

The foregoing comparisons have been based upon Frasch's actual operations, and to a large extent on the early operations of the Grebe and Sanford process, where comparatively small amounts of acid were employed. As the success of the Grebe and Sanford process became established and well known, larger and larger volumes of dilute acid were used to reach further out into the limestone and open up more oil for recovery. Eventually, at least in some cases, the Grebe and Sanford process used volumes of dilute acid quite comparable with the volumes of concentrated acid used by Frasch. The operations and results of the two processes when practiced in that way deserve a brief additional consideration. Assuming that both processes start with the same amount of concentrated acid, Grebe and Sanford dilute their charge to twice the volume of Frasch's charge and it therefore saturates twice as much rock. Furthermore, because of the dilution it reacts less violently, that is more slowly, and therefore can preserve a higher percentage of its reactive capacity while it is being forced through the minute pores of the rock. Frasch's charge not only would saturate much less of the rock, but in all probability would do a higher percentage of its work close to the well hole. Finally, Frasch introduced his acid slowly while Grebe and Sanford use pressure to force their acid into the rock comparatively quickly, having developed an acid pump in connection with their earlier work in acidizing brine wells. (R. 1410.) Briefly, Grebe and Sanford with their dilute acid tend to erode a thin layer from the pores in a large volume of rock, while Frasch takes a comparatively thick layer from the pores in a much smaller volume of rock. Since the desired operation

is to facilitate the flow of oil from a large volume of rock into the well hole, it is evidently far better to attack the larger area of rock for any given expenditure of acid.

Thus, entirely aside from the convenience, simplicity and low cost of introducing the Grebe and Sanford charge, due primarily to the use of an inhibitor, their dilute acid process has great economic advantages over the use of equal amounts of active acid in a concentrated solution.

Claim 8 of the Grebe-Sanford patent covers their preferred operation. This claim plainly brings out the three points in which their process differs from the Frasch process, *i.e.*, (1) the use of dilute acid, (2) the addition of an inhibitor, and (3) the introduction of the charge through the regular pump tubing which is already in place in the well. This is the process used by the petitioner and its licensees and also by the respondent, it is the best process, and it is the process which created commercial success.

Undoubtedly, when their application was filed, and during its prosecution, Grebe and Sanford were interested primarily in covering their best process which is practically innocuous to the steel in the well structure. In retrospect, we see now that they might well have insisted upon and obtained a claim similar to claim 8, but not limited to the use of an inhibitor.[33] Such a claim would have covered an entirely novel process and one which should give highly beneficial results as compared with Frasch's failure, although not nearly as useful as the process they claimed and use. However, the fact that Grebe and Sanford did

[33] The chief element of novelty in the ore flotation process was the small amount of oil used; also it differed from prior processes in simplicity of operation. *Minerals Separation vs. Hyde*, 242 U. S. 261; *Minerals Separation vs. Butte, etc.*, 250 U. S. 336. In sustaining the patent the court, in the first of these cases, stated: "The simplicity of the operation, as compared with the prior attempts, is startling. * * * yet the investigations preceding were so informing that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony and in the claims of the patent as 'critical proportions' amounting to a fraction of one per cent on the ore, * * *'."

not cover all their novelty does not make the unclaimed part of their disclosure prior art to be used against them.

POINT II. THE OPERATIONS OF OIL MAKERS COMPANY AND CHEMICAL PROCESS COMPANY ARE NEITHER PRIOR ART NOR THE FRASCH PROCESS

The Oil Makers Company treated its first well in July, 1932, after its officers knew about the Grebe-Sanford treatments. (R. 1214.) Chemical Process Company started its operations still later, having learned of Oil Makers' operations. (R. 1003.) Therefore, anything those companies did was not a prior use, and evidence regarding their operations can be relevant only on the theory that they were using the old Frasch process and that their operations demonstrate the practicability and success of that process.[30]

Both companies used approximately 15% acid, which they ran into the well through the regular pump tube. Oil Makers at first used dilute acid without an inhibitor, which caused so much damage to well equipment that it soon changed to the more expensive inhibited acid and thus became an infringer. (*Supra*, pp. 19, 20.)

Insofar as the operations of Chemical Process Company are concerned, a single interested witness, the vice president of the company, testified that uninhibited acid was used in a large proportion of its treatments. No samples of its acid nor any analysis thereof was produced, but there is convincing proof, with introduction of samples, that the company surreptitiously inhibits its acid by placing rolls of sheet lead in its delivery tanks so that the inhibitors, lead and copper chlorides, are present in the acid when run into the well, just as they are in respondent's operations which both courts held to infringe.

(30) A single deposition was offered by defendant to prove the operations of Chemical Process Company. This was objected to as irrelevant and admitted over the objection on the ground that it was the old Frasch process. (R. 1007.)

Oil Makers caused so much damage to the well equipment when they used raw 15% acid that, despite the increased oil recovery of the wells treated, they were obliged to change to an inhibited commercial acid known as Duclean No. 2 and marketed by Grasselli Chemical Company. Undoubtedly, there was a great deal more damage done than was actually ascertained. Damage would only be discovered and complaint made when the well tubing was so eroded as to leak, fall apart at the joints, or otherwise demonstrate that it had been injured. In many cases the well tubing could be seriously damaged without giving any immediate sign that it had been impaired, but however that may be, the damage was admittedly sufficient to force the Oil Makers Company to change to directly infringing operations.

If it be assumed that Chemical Process Company did use uninhibited acid, the success or failure of its operations cannot be material, since it was not Frasch, nor was it a prior art process. To be the Frasch process, the only prior art suggestion to treat the producing formation with acid, the process must have employed concentrated acid introduced through a special acid supply pipe. Had such a special supply pipe not been used far more damage to the well equipment would have resulted than was caused by Oil Makers during the short period when it used dilute uninhibited acid. No sane operator would dream of putting concentrated acid through many hundreds of feet of valuable unprotected steel tubing. The result would be not only ruin of the tubing, but the expenditure of a large part of the acid strength on it and on the walls of the well hole instead of within the producing formation, with no assur-

ance of better results in increased yields than those obtained by Frasch.

The Court of Appeals laid great stress on the operations of the Chemical Process Company, stating that it has, since 1932, "successfully acidized 15,000 wells serving most of the major oil companies, and using in almost all instances raw acid. *Thus it has been employing the Frasch method.*"

This demonstrates a complete misunderstanding of the admitted facts and also raises an immaterial and improper issue. This company diluted 18° Baumé hydrochloric acid with equal quantities of water and introduced the mixture through the pump tubing (R. 1003). It admittedly used inhibited acid early in its practice. (R. 1004.) It claims to have abandoned inhibited acid while the Tenth Circuit case was on appeal and before the decision holding the patent in suit valid. Even if that were true, its operations can have no bearing on the present case. They would then have been the same as the first operations of the Oil Makers, *i.e.*, with *dilute* raw acid pumped *down the well tubing* and expelled by pump pressure. That was not the Frasch process, but a new process developed in the light of the Grebe-Sanford invention, in an effort to obtain some of the benefits of their great discovery without using enough to infringe. It is utterly immaterial that something different from what Grebe and Sanford claimed would be measurably successful, unless that process were really prior art, which it clearly was not. These operations, therefore, were not the Frasch operations, and they give no light whatever on whether the Frasch process could have succeeded.

However, the operations of Chemical Process Company are open to another and entirely different attack. Since the patent in suit was held valid in the Tenth Circuit, Chemical Process Company has been using a means to inhibit its acid which is substantially the same as that used by respondent and held by both courts to be an infringement if the patent in suit is valid.

Whereas the Oil Makers Company transported its raw acid to the wells in wooden tanks (because it was warned by the manufacturer of the acid that the acid would destroy a steel tank) and thus got its acid in honestly raw condition to the wells, respondent and Chemical Process Company use steel tanks for transporting their acid and have adopted subtly ingenious methods of inhibiting the acid before it is run into the oil well tubing. (R. 116.)

Respondent rigged up an electric battery system in which lead plates in the tank were one pole and the steel wall of the tank was the other pole, and thus considerably reduced the attack of the acid on the transportation tanks. (*Infra*, pp. 64, 65.) However, at the same time and as an incident to this method of protecting its tanks, there is dissolved in the acid enough copper and lead greatly to reduce its corrosiveness of iron and steel. Both the District Court and the Circuit Court of Appeals held that this alteration of the acid by respondent (which due to the ingenious nature thereof was proved only with great difficulty by evidence which occupies fully half of the present record) was such that its use in treating oil wells constitutes infringement of the patent in suit, if the patent is valid. Thus, in respondent's case, its loud protestations that it uses no inhibitor were unhesitatingly overruled.

The only testimony in the record to the effect that Chemical Process Company uses no inhibitor in its acid is the uncorroborated statement of a single interested witness, the vice president of that company, which certainly ought to be given no greater weight than respondent's similar insistence that it uses no inhibitor. (R. 1003-6.)

While the whole subject of the Chemical Process Company's operations should never have been admitted in evi-

dence or considered at all, because the process obviously is not prior art and is not the Frasch acid process, yet when it was made an issue petitioner proved that rolls of sheet lead are present in the steel transportation tanks used by Chemical Process Company to transport its acid from the storage tank to the wells. (R. 1301-6.) Thus, Chemical Process Company's acid was proven, by the presence of lead sheets in its steel tanks, to be secretly and subtly inhibited just as is respondent's, and we cannot understand why the Court of Appeals should accept the assertions in a single deposition, and that of an officer of the company, that it does not use an inhibiter when it squarely overruled precisely the same assertion by respondent.

Both respondent and Chemical Process Company have sheet lead in their transportation tanks. The presence of the lead sheets in its tanks was found to cause inhibition of respondent's acid (R. 592) and it must also in the Chemical Process case. In respondent's case, we proved the inhibition beyond the possibility of doubt, because that was a direct issue in the litigation. We should not be punished for failing to offer similar, equally involved proofs in the case of another infringer, who claims no more than respondent did, especially when such proofs would not have related to anything that was done prior to the date of the Grebe-Sanford invention.

Of course, the shortest and best answer to the Chemical Process evidence is that since it is a dilute acid process applied through the regular well tubing and not the Frasch process, and since it does not follow the prior art at all, it has no place in the case. Any measure of success the Chemical Process Company may have had is not, as the Court of Appeals mistakenly assumed, a demonstration of the Frasch process.

POINT III. THE GYPSY OIL COMPANY EXPERIMENTS IN SANDSTONE WELLS

The court in the Tenth Circuit was undoubtedly right in its conclusions as to the Gypsy operations when it stated that they constituted nothing more than an abandoned experiment, and were not an anticipation, even if proven to be successful. The most that can be claimed for this experiment, based on the reports and correspondence, is that it was technically operative to remove scale from the well wall and equipment, but without increasing production and at such prohibitive cost (R. 1685) as to make the process a commercial failure, with the incidental undesirable result of releasing quantities of loose sand which accumulated in the well hole and had to be removed before the well could be pumped. (R. 1682-3, 1677.)

The District Court found that Gypsy used inhibited concentrated hydrochloric acid for removing scale from three of its wells in the Glenpool sandstone field during 1928 and 1929. (R. 1488.) There is some evidence that Gypsy made similar experiments in other wells, using uninhibited acid. Its last effort to remove gyp with inhibited acid was in September, 1929, and its last effort to use raw acid for that purpose was in March, 1931.

This scale removal experiment, even though technically operative to remove scale, did not and never would have taught anyone to pump large volumes of inhibited dilute hydrochloric acid down through the pump tubing and out into the rock formation in limestone wells for the purpose of increasing production.

After a lapse of nearly two years after the Gypsy Glenpool experiments, during which it made no effort to revive this scale removal experiment, Gypsy learned of the success of the Grebe-Sanford process in increasing the production from limestone wells and immediately adopted

it, as did everyone else for such wells, and has used it extensively ever since.

Everybody who produced oil from limestone wells needed the Grebe and Sanford process. Gypsy's technical oil men and geologists, dozens of them, knew all they ever learned about the Gypsy process as early as November 12, 1928, when the first Gypsy test was made, and Gypsy needed the Grebe and Sanford process just as badly then as it ever needed it later, yet for four and one-half years that knowledge did not lead it to go into its closely adjacent limestone fields with the Grebe and Sanford process or with anything even remotely resembling it. On the contrary, it made no attempt to increase the production of its limestone wells by acidizing them until it learned of the success of the Grebe-Sanford process early in 1933, after which it used that process extensively through the employment of petitioner's licensees and also in treating its own wells. (R. 1088, 1090, 1704.)

The theoretical assumption that Gypsy's scale removal experiment in 1928 taught its skilled geologists and production engineers how to increase the production of their limestone wells by the Grebe-Sanford process is absolutely irreconcilable with the proven practical facts that Gypsy waited over four years before having any of its numerous limestone wells treated with the Grebe-Sanford process and applied that process to nearly one hundred other wells within a few months thereafter. (R. 1088, 1090.)

It is simply absurd to argue that if the technically operative experiment in scale removal in Glenpool field really taught the present process, Gypsy would have waited over four years before putting that knowledge to work.

If, as the Court of Appeals for the Sixth Circuit found, the Gypsy concentrated acid scale removal process *anticipated* the patent in suit, *i.e.*, taught the same thing, Gypsy certainly would have resorted to its use immediately instead of dropping it completely, even for its limited purpose, and later turning to petitioner's licensee to provide it with the vast increases in yield which it obtained from the use of the Grebe-Sanford process.

The first well to which the Grebe and Sanford process was applied for Gypsy by plaintiff's licensee showed a gain of 555 barrels per day, and among the first few wells treated were gains of 248 barrels and 95 barrels. (R. 1104.)

The court in the Tenth Circuit was entirely right in finding that the Gypsy process was nothing more than an abandoned experiment and that it would not have anticipated even if fully established. Abandonment is a question of fact, and the duration of abandonment is only evidentiary. From March, 1931, Gypsy dropped all efforts at scale removal by the use of acid, either inhibited or uninhibited. (R. 1088.) Thereafter it tried various other means for removing scale and in April, 1932, it was using a mechanical scraper for this purpose and recommending the extension of such use to other wells. (R. 1693.) In February, 1933, nearly two years after it had completely dropped the acid treatment for scale removal in sandstone wells, it adopted, with justified enthusiasm, Grebe and Sanford's process in its limestone wells, not to descale tubing but to increase their production, which it continues to use.

These two processes are on their face widely different, designed for different purposes and deal with the acid in different ways. One failed commercially, even for its very minor intended purpose. The other became an overwhelming success. In retrospect, the differences may not seem great, but it is absurd to assert that in any sense the Gypsy process is a true anticipation. Its failure and abandonment should disqualify it as prior art, but the statement of the Court of Appeals that the process *anticipates* simply shows an egregious misunderstanding of the facts.

The Gypsy process does not even approximate claim 8. It is an accepted axiom of patent law that what infringes if later anticipates if earlier and *vice versa*. The claim calls for dilute acid, where Gypsy used concentrated. The claim calls for introducing the acid through the pump tubing and forcing it by pressure from there into the rock. Gypsy did nothing of the kind, but, on the contrary, sought to avoid any penetration of the acid into the sandstone rock because it would eat out the soluble binder and deposit loose sand in the well hole. Gypsy simply partly filled the well casing and tubing with the body of acid and held it there by vacuum and let it react. There plainly is no *anticipation*.

These abortive experiments ought not to be held relevant as prior art. They never taught anybody anything, and never would have been heard of again except that someone wanted to make capital out of them in litigation. But even if treated as prior art they taught nothing that everybody didn't know already. It was known that hydrochloric acid would eat limestone. It was known that inhibited hydrochloric acid would not eat iron, but would eat calcium carbonate. It was known that wells had tubing in them, and it was known that a large proportion of every oil deposit remained underground after all known methods of recovering it were exhausted. Every oil producer wanted to recover more oil, yet it remained for Grebe and Sanford to combine these separate elements of knowledge to form a single operative process which added immeasurably to our national wealth, to a very great extent solved an ancient and theretofore unsolved problem, and which today is used to treat wells in practically every limestone oil-producing field in this country.

Nothing Gypsy did in its efforts to remove scale from the equipment in its sandstone wells with small quantities of concentrated hydrochloric acid remotely suggested the

wisdom of introducing into the producing formation large volumes of dilute hydrochloric acid to increase the production of limestone walls. The problems and results were entirely different. Gypsy wanted to work entirely within the well, and it properly used concentrated acid to get the quickest and most localized action. The acid being neutralized by reaction with the gyp scale before it could reach the tubing, no inhibitor was necessary and none was used in two-thirds of the treatments. Grebe and Sanford wanted to work as far from the well as possible, to open up the pores in the largest volume of limestone. The Gypsy Company introduced just enough acid to fill the gyp covered pipe and very carefully held it there, where it exhausted itself on the gyp, whereas Grebe and Sanford use large quantities of dilute acid which they expel from the well tube into the bore of the well and out into the rock to act, not on materials within the well, but on the rock pores. The processes are entirely different, and are for entirely different purposes.

CRITERIA OF INVENTION

This court in 1851 declared that to be valid a patent must display not only novelty, but novelty of a kind beyond the skill and ingenuity of "an ordinary mechanic acquainted with the business" (*Hotchkiss vs. Greenwood*, 11 How., 52 U. S. 248, 267). In applying this rule it presently appeared that while most cases require a retrospective comparison of the inherent ingenuity of the patentee's concept with the ingenuity expected of the hypothetical skilled mechanic, yet a comparatively small proportion of the cases require only objective historical examination.

When a serious and recognized need exists for a long time and the means to fulfill the need are always available, the "ordinary mechanic acquainted with the business"

would certainly solve the problem if it were within his capacity. The continued failure of a whole industry to solve a problem conclusively proves that the ordinary mechanic cannot solve it. The uncertain test of "retrospective simplicity" always gives way to the objective test of history when that is available.

Retrospective comparison often leads to special unfairness when made by a brilliant jurist who naturally postulates an ordinary mechanic possessed of acumen equal to his own, a clearly false hypothesis. Whole industries sometimes get into such mental ruts that they miss the simplest things, completely justifying this Court's reference to "the common history of important inventions, the simplicity of which seems to the ordinary observer to preclude the possibility of their involving an exercise of the inventive faculty" (*Carnegie vs. Cambria*, 183 U. S. 403, 429).

In view of the recent full consideration of the long-felt-want rule in *Goodyear Tire and Rubber Co. vs. Ray-O-Vac Co.*, 321 U. S. 275, a complete argument of the point seems unnecessary. Other outstanding cases in this Court in which patents were sustained under the long-felt-want rule are as follows:

Smith vs. Goodyear Vulcanite Co., 93 U. S. 486, the Hard Rubber Toothplate Case.

Barbed Wire Patent Case, 143 U. S. 275.

Krementz vs. S. Cottle Co., 148 U. S. 556, involving the one-piece collar button.

Carnegie vs. Cambria, 185 U. S. 403, involving the dominant pool in which by blending successive charges of molten pig iron from blast furnaces, sufficient uniformity of composition was obtained for Bessemer Converters.

Smith vs. Snow, 294 U. S. 1, involving the use of a circulating fan to get uniform temperature in an incubator.

The inventions upheld in these cases certainly could not have stood the misleading test of retrospective simplicity for they were all extremely simple and in at least two of them (*The Barbed Wire Case* and *Cargenie vs. Cambria*) this Court said it was strange that the invention had not been made earlier.

Furthermore, this Court in *Paramount vs. Tri-Ergon*, 314 U. S. 84, 94, although holding the patent void for want of invention, plainly suggested that had the facts justified applying the long-felt-want rule, the result would have been different.

The same position was taken in the concurring opinion of Mr. Chief Justice Stone and Mr. Justice Frankfurter in *Cuno Engineering Company vs. Automatic Devices Company*, 314 U. S. 84, which restates the long-felt-want rule and distinguishes from it on the facts.

In *Goodyear Tire and Rubber Company vs. Ray-O-Vac Company*, 321 U. S. 275, an extremely simple device was held patentable under the long-felt-want rule. This case is so recent that we only remind the Court that the invention was a dry battery rendered "leak-proof" by the use of a steel shell insulated from the electrodes and tightly embracing the ends of the cell.

Finally, in *Universal Oil Products Company vs. Globe Oil and Refining Company*, 322 U. S. ...., the Court seems unanimously to accept the long-felt-want rule when it says (p. 1117):

> "Retrospective simplicity is often a misleading test of invention where it appears that the patentee's conception in fact solved a recognized problem that had baffled the contemporary art."

The opinion correctly differentiates the Egloff patent on its facts from the rule here invoked.

The House of Lords (The Lord Chancellor Viscount Simon, Lord Russell of Killowen, Lord Macmillan, Lord

Romer, and Lord Wright) recently took the same position as that of this Court and on the same grounds of logic. It said in *Non-Drip Pressure Coy., Ltd. vs Stronger's Ltd.*, 60 R. P. C. 135 (Opinion by Lord Russell of Killowen):

> "It is always pertinent to ask, as to the article which is alleged to have been a mere workshop improvement, and to have involved no inventive step: Has it been a commercial success? Has it supplied a want? Some language used by Tomlin J. in the case of *Samuel Parkes & Coy., Ltd., vs. Cockey Bros., Ltd.** may be cited as apposite: 'Nobody has told me, and I do not suppose that anybody ever will tell me, what is the precise characteristic or quality the presence of which distinguishes invention from workshop improvement. * * * *The truth is that when once it has been found that the problem has waited solution for many years, and that the device is in fact novel and superior to what had gone before, and used in preference to alternative devices, it is practically impossible to say that there is not present the scintilla of invention necessary to support the patent.*' As to the commercial success of the plaintiffs, there can, in my opinion, be no doubt. In 1935, 450 measures were sold, in 1936, 7,996, in 1937, 16,700, and in 1938, 18,400. In the war years the sales naturally fell off, but the success of the machine was immediate and great. That there was a need for such a machine was clear from the defects in those already on the market. Nor should it be forgotten that as far back as the year 1908 Newland was trying to solve the problem of producing a machine which would deliver measured quantities of liquid without requiring one hand of the operator to be left free to operate the valves. He failed to produce a practicable or marketable machine. It is not until 27 years have elapsed that the successful machine is forthcoming, which achieves the object at which Newland aimed. *If during that long period it only re-*

*46 R. P. C. 241, 248.

quired a workman to be told to adapt Newland to upward pressure, for him to produce a machine as claimed in the plaintiff's patent, it is hard to understand why the production was so long delayed. There can, I think, be only one explanation, and it is that before such a machine could be produced an inventive step had to be taken, and that those who took out the plaintiffs' patent were the first to take it."

Lord Romer added:

"Now that the idea has been carried into effect it is easy to take the steps one by one and say that individually they involve no inventive step. For it is well settled that this is not a legitimate method of approach."

While the objective historical test leads to sustaining some patents which the test of retrospective simplicity would strike down, it is actually a more severe test than that commonly applied. Under the broad rule a concept is inventive if beyond the expected skill of the "ordinary mechanic acquainted with the business." When this rule is applied by the method of retrospective comparison, the measuring rule is not the skill of the most intelligent mechanic, but of the ordinary mechanic, just as in negligence cases the measuring rule is not the care of the most careful man, but that of the ordinarily prudent man.

When, however, history justifies the application of the long-felt-want rule, the concept is shown to be one which by the test of time is beyond the capacity of the whole industry, including not only its ordinary mechanics, but also its trained research men, its inventors, and its men of genius, if there were any in the industry. The present record is replete with abortive efforts by many men to get more oil out of the ground. Thirty-five years elapsed between Frasch's failure and the Grebe and Sanford success and during that time scores of good men worked on the prob-

lem. The facts show that the retrospective test is inapplicable.

Of course, in determining whether to apply the long-felt-want rule this Court must re-examine the facts, since on this point there is a diversity of view between two Circuit Courts of Appeals (*Universal Oil Products Co. vs. Globe Oil and Refining Co.*, 322 U. S. ....; *Sanitary Refrigerator Co. vs Winters*, 280 U. S. 30, 35-6). On the facts, however, there is little room for dispute when the evidence is carefully examined. The Frasch process was so poor that it was completely abandoned in 1896 and has never again been revived. The Grebe and Sanford process, differing in several respects, successfully accomplished the result Frasch vainly sought and was and is an overwhelming success.

One part of the factual basis for applying the long-felt-want rule usually is direct evidence as to the existence of the problem. That appears here from the testimony of experts concerning the oil left unrecovered by prior methods and the history of many abortive efforts to recover it.

It must also be proved that the invention before the court solves the problem. That may be shown either by direct evidence of improved results or circumstantially by widespread acceptance of the invention, or both.

When an invention can be brought within the rule by direct proof that the problem has been solved there need be no proof of widespread adoption, since a patentee might prefer to keep the invention for his own limited use and reap the profits resulting from reduced cost. Indeed, in *Carnegie vs. Cambria* the patentee for some years kept the invention within its own plants, and much of the extensive use arose from the large size of the plaintiff company. Yet the direct evidence concerning the existence of

the problem and its satisfactory solution gave adequate factual basis for applying the historical rule.

When, however, the invention is of a kind or is so handled, as it has been here, that it is widely and rapidly accepted, this fact circumstantially proves both the continuing existence of the need and its satisfaction by the invention. While the present record contains ample direct evidence of the existence of a problem and its solution by the Grebe and Sanford method, the immediate and universal adoption of the method in all limestone fields supplies adequate circumstantial evidence, independent of the direct proof, to call for the application of the objective historical test rather than the uncertain test of retrospective simplicity.

The application of these long-established principles to the facts here requires a reversal of the decree of invalidity.

BRIEF FOR CROSS-RESPONDENT ON THE QUESTION OF INFRINGEMENT

The cross-petition raises the question of infringement. Voluminous proofs were taken on this subject, including the testimony of two experts for each party, which comprises approximately one-half of the printed record in this case. The trial court held that defendant had appropriated the process of the Grebe and Sanford patent No. 1,877,504 if that patent were valid,[35] and the Court of Appeals con-
two courts in this case and the fact that there is no conflicting opinion by any other court, it is not believed that the question of infringement is open here.

> Continental Paper Bag Co. vs. Eastern Paper Bag Co., 210 U. S. 405, 416, 422; 28 S. Ct. 748, 750, 752.
>
> Adamson vs. Gilliland, 242 U. S. 350; 37 S. Ct. 169.
>
> Williams Manufacturing Co. vs. United Shoe Machinery Corp., 316 U. S. 364, 367; 62 S. Ct. 1179, 1181.
>
> Goodyear Tire & Rubber Co. vs. Ray-O-Vac, 321 U. S. 275; 64 S. Ct. 493, 594.

STATEMENT OF THE CASE ON THE CROSS-PETITION

The cross-petitioner, Halliburton Oil Well Cementing Company, was organized in 1924 primarily to cement and service oil wells. Erle P. Halliburton organized it, has always been its president and at all times has owned or controlled a majority of its stock. (R. 240.) Before its
curred in this finding.[36] In view of this concurrence by the

---

(35) Finding 84 (R. 1490) and conclusion of law 2 (R. 1942). This fact finding follows in substance the language of patent claim 8.
(36) R. 2054.

organization he was thoroughly familiar with oil production, had worked in the oil fields of California, Texas, Oklahoma, Arkansas and Louisiana, and had owned interests in oil wells. Later, he organized and controlled two oil producing companies—Steen Drilling, Inc., and Erle P. Halliburton, Inc. (R. 241-2.)

Asked whether prior to 1932 he had known of efforts to increase production of limestone wells, Halliburton stated that he had redrilled wells, lots of them, prior to that time, that he knew of shooting methods where a lime formation was shot with nitroglycerine to break the formation, and that he had used acid in a well either in December, 1919, or January, 1920.(37) He also had known of flood-paraffin. (R. 243-5.)

In March, 1934, Steen Drilling, Inc. employed Dowell, Inc., to use the Grebe-Sanford process on two limestone wells in Louisiana (R. 1632), and in April, 1934, Steen Drilling, Inc., and Erle P. Halliburton, Inc., employed Dowell to acidize by the same process ten or more limestone wells in Louisiana, Oklahoma, Kansas, Texas or New Mexico. (R. 1635.)(38)

After thus learning about the Grebe-Sanford process the cross-petitioner branched out into the business of acidizing wells to increase production, using dilute hydrochloric acid introduced through the regular pump tube.

(37) This use of acid, according to respondent's counsel, "related to getting out drill pipe or tools that had been stuck in a well and using the acid to cut that limestone, * * *."

ing and vacuum methods, and of the use of heat to dissolve

(38) Exhibits 38, 40, 43 and 46 (R. 1639-40) are purchase orders, dated March, April and May, 1934, issued to Dowell by Steen Drilling, Inc., and Erle P. Halliburton, Inc., for 1,000-gallon, 1,500-gallon and 2,000-gallon acid treatments for specified wells, and Exhibits 52, 54, 57, 59, 62, 64 and 66 (R. 1641-48) are receipts for acid treatments made by Dowell for Steen Drilling, Inc., or Erle P. Halliburton, Inc., dated in July, August, September, October, November and December, 1934. On November 9, 1934, Erle P. Halliburton, Inc., purchased from Dowell 1,000 gallons of "Dowell X," being the trade-name for Dowell's inhibited hydrochloric acid used in practicing the Grebe-Sanford process. (Exhibit 27, R. 1631.)

On the first few wells it used no inhibitor, but soon changed to inhibited acid, as Oil Makers Company had done in 1932. (R. 256.) The witness Hoisington, who had charge of the early acidizing operations of the cross-petitioner, testified (R. 256):

> "* * * During the time that I was in charge in Kansas I used inhibited acid after, I think, the second or third job which was about January and February, 1935. The inhibitors used, as I recall, were Nep 22 and Murodine. * * *
>
> "We used these inhibitors up until the Circuit Court of Appeals handed down the decision in Denver, in the case of *The Dow Chemical Company vs. Williams Brothers Well Treating Corporation*, which was about 1936. I used the inhibitors, Nep and Murodine, in my district in Kansas from early in 1935 up to 1936, and those are the only inhibitors I recall using during that period."

Instead of merely dropping the use of the inhibitor and continuing its operations with dilute raw acid, as it claims Chemical Process Company was then doing with great success, the cross-petitioner entirely discontinued its acidizing business shortly after the decision of the Circuit Court of Appeals in the *Williams* case in January of 1936 (R. 262-3), and did not resume the acidizing of wells until it had devised the method of subtly inhibiting its acid by inserting sheet lead in its transportation tanks, which both courts below held to infringe. This method was first described in a booklet entitled "Howco Method of Protecting Tubing and Casing Against Corrosion While Acidizing a Well," published in March, 1937. (R. 587-90, PX-186.) In this Howco method respondent brazes a number of lead sheets to the inside bottom of the steel tanks in which it transports its hydrochloric acid from the acid storage station to the wells. (R. 261 and Exhibit 71, p. 1649.)

When the acid covers these lead plates a battery system is set up one effect of which is to create in the acid minute quantities of copper and lead chlorides. These are effective inhibitors when present in these proportions and it was because of their presence in the acid when used in the wells that the lower courts held the cross-petitioner's process to infringe. Tests of the samples of the storage and well-treating acids employed by cross-petitioner disclosed that these inhibitors were formed in the acid after it left the storage tanks.

At the trial the following steps were proven and held to constitute infringement:

1. Cross-Petitioner Uses Dilute Acid

Cross-petitioner purchases raw 30% commercial hydrochloric acid and stores it in wooden tanks at its treating station at Mt. Pleasant, Michigan. Before using it to acidize oil wells it is diluted to about 15% strength by the addition of water. (R. 307, 314, 315, 320, 326, 328, 342, 345.)

2. Cross-Petitioner's Treating Acid Sampled at the Wells Was Much Less Corrosive to Iron Than Was Its Diluted Storage Tank Acid

This point was proved by Dr. Bartell, head of the department of chemistry at the University of Michigan. Samples of cross-petitioner's storage and treating acids were delivered to and tested by him to determine to what extent they were inhibited. He immersed strips of strap iron of uniform size and of oil well tubing of uniform size in 50 c.c. of the storage and treating acids for 16 hours, and measured the loss in weight of the strips. The results are tabulated in Bartell's Tables I to VIII, Exhibits 154 to 159. (R. 1705-10.)

In these tables the results are stated as "% Reduction in Corrosiveness" of the acids as compared with chemically pure hydrochloric acid which was taken as being 100% corrosive. The tables show an average reduction in the corrosiveness of the treating acid of about 52% with strap iron test pieces (R. 335) and about 42% with oil well tubing test pieces (R. 337-8), whereas the average reduction in corrosiveness of cross-petitioner's storage acid, which had not been in contact with the lead of its transport tanks, was only about 8.3% when tested with pieces of strap iron and about 10% when tested with pieces of oil well tubing. (R. 1709-10.)

Analyses showed that cross-petitioner's treating acids contained much more dissolved copper, lead and iron than did this storage acid.[39] Stated in parts per million, the treating acids contained an average of 3.8 of copper, 302 of lead and 354 of iron, whereas the corresponding figures for the storage acids, after dilution, were 0.46, 4.7 and 8.9.

Synthetic acid solutions were made up by adding to chemically pure HCl various amounts of lead, copper and iron, singly and in different combinations, and tests of these were made to show the effect of these additions in reducing the corrosiveness of the acid, that is, to show whether these metals, or some of them, as found in cross-petitioner's treating acid, are inhibitors. (R. 390-4; 398-406.)[40] In these tests the addition of copper alone in amounts of from 1 to 100 parts per million reduced the corrosiveness of the acid by from 20% to 40% and the reduction in corrosiveness was especially rapid when the amount of copper was increased from one part per million

---

[39]The amounts of these metals found to be present in the treating acid samples are shown in Exhibit 160 (R. 1711); the amounts found in the storage acids, before dilution, are shown in Exhibit 161 and after dilution to the strengths of the treating acids are shown in Exhibit 162 (R. 1712).

[40]The results of these tests are shown in Bartell's Table XVIII, Exhibit 166 (R. 1716-18).

to 3.5 p.p.m., 1 p.p.m. showing a reduction of 20% and 3.5 p.p.m. showing a reduction of 33%. Respondent's acid contained an average of 3.8 p.p.m. of copper.

The maximum effectiveness of the lead alone appeared at about 320 p.p.m., which caused a reduction in corrosiveness of 12%, whereas 160 p.p.m. caused a reduction of only 6%. 420 p.p.m. caused 13%, or only 1% more than 320 p.p.m. Respondent's acid contained an average of 302 p.p.m. of lead. Iron alone had little or no effect.

The combination of these metals most effective in reducing the corrosiveness of hydrochloric acid solutions was 3.5 p.p.m. of copper, 420 p.p.m. of lead and 440 p.p.m. of ferric iron, which closely approximates cross-petitioner's treating acid, which contained an average of 3.8 of copper, 302 of lead and 354 of iron. (Solution No. 68, R. 1718.)

In order to simulate the flowing motion of the acid in the well tubing during an acidizing treatment, Dr. Bartell ran tests with synthetic acid samples in which the acid was agitated, some of these tests being with 50 c.c. of acid and others with 300 c.c. (R. 407-8). The results showed that agitation further reduced the corrosiveness of the inhibited acid solutions and that increasing the relative volume of the acid still further reduced its corrosiveness, these effects being cumulative in the 300 c.c. tests. (R. 1719, Exhibit 167.)

The results of Dr. Bartell's various tests are accumulated and shown graphically on Plaintiff's Exhibit 170 (R. 1721), which is explained at R. pp. 428-431. The black horizontal lines indicate corrosiveness, the upper one showing chemically pure acid as 100% corrosive. The next six black lines show the corrosiveness of different solutions of Exhibit 166 (R. 1716). For example, solution No. 2 was 15.1% chemically pure acid plus 3.5 p.p.m. of copper, and the corrosiveness of 50 c.c. of the solution was 33% less than that of the unadulterated chemically pure acid. The

fourth black line from the bottom shows that agitation of 50 c.c. of the No. 2 solution made it 9% less corrosive than it was without agitation, and the last three black lines show the effect of both agitation and increased amounts of the solution. These last four black lines are based on Exhibit 167. (R. 1719.)

Dr. Bartell's findings on the inhibitive effect of small amounts of copper, lead and iron dissolved in hydrochloric acid were corroborated by Dr. Carl F. Prutton, who is in charge of the Chemistry and Chemical Engineering Departments of Case School of Applied Science. He made a series of tests in which one-inch sections of Oil Well Supply Company 1¼" oil well tubing were suspended *without agitation* in 1360 c.c. of chemically pure HCl to which had been added different small amounts of lead, copper and iron. (R. 501-5.) The results are shown in Exhibits 173-A to D (R. 1726-28). Seven series of tests were made, one using chemically pure acid and the others using similar acid to which the three metals, copper, lead and iron, had been added in different amounts. Tests of these six synthetic acid solutions showed reductions in corrosiveness of from 59.7% to 71.4%. Sample No. 3 is the one whose metal content was closest to the average of cross-petitioner's truck samples. It contained 3.72 p.p.m. of copper, 242 p.p.m. of lead and 473 p.p.m. of iron, and gave a reduction in corrosiveness of 70%.

Dr. Prutton also made a number of large scale tests in each of which he used approximately 200 gallons of commercial hydrochloric acid bought from Grasselli Chemical Company, and diluted to approximately 15% by adding water. This was run through 112 feet of 1¼" oil well tubing at the rate of one gallon per minute. In some runs the raw acid was used and in others small amounts of copper, lead and iron were added to the acid. The results of

these runs are shown in Exhibits 176 to 183. (R. 1734-41.)

Exhibits 176 to 179 show the results of four runs using the raw HCl reduced to 15% strength. The iron picked up by the acid in its passage through the tubing (due to corrosion) was 1043, 943, 919 and 791 grams, respectively, an average of 924 grams for the four runs. In the other four runs (Exhibits 180 to 183) small amounts of copper, lead and iron were added to the acid solutions in an effort to duplicate substantially the amounts of those metals found by Dr. Bartell in cross-petitioner's treating acid. The amounts of copper in the acid at the start of the four runs were respectively 2.78 p.p.m., 3.07 p.p.m., 3.71 p.p.m. and 3.8 p.p.m., and the lead contents were respectively 390, 316, 455 and 340 p.p.m. The iron taken up by the acid in these four runs was 238, 299.8, 195 and 101.4 grams, respectively, an average of 208.5 grams, as compared with an average of 924 grams on the four runs using commercial HCl without any addition of inhibitors. These tests are discussed at R. 510-32.

The results of these tests, computed by Dr. Prutton and expressed in grams of iron dissolved per hundred feet of tubing per hour of contact, show that the amount of iron dissolved off the tubing by the raw commercial acid was 264.5 grams as compared with 59.4 grams by the inhibited commercial acid. Hence, the inhibited acid was less than one-quarter as corrosive as the raw acid. (R. 517, 532.)[41]

Dr. Prutton's results fully confirm those of Dr. Bartell in demonstrating the effectiveness of lead and copper and

---

[41] These tests are explained by Dr. Prutton (R. 501-5) and the results of the tests are shown graphically in Exhibits 187 and 189 (R. 1752, 1754), the method being the same as explained in connection with Dr. Bartell's graph, Exhibit 170 (R. 1721). Exhibit 189 (R. 1754) shows the results of Dr. Prutton's seven sets of small scale tests, shown in tabular form in Exhibit 173-A (R. 1726), and Exhibit 187 (R. 1752) compares the average of his four large scale runs with raw commercial acid (R. 1734-37), which average is taken as showing 100% corrosiveness, with each of the four large scale runs in which he added copper, lead and iron to similar raw commercial acid.

the ineffectiveness of iron as inhibitors, and his tests further show that the reduction in corrosion due to the presence of inhibitors is considerably greater with actual oil well tubing and flowing acid than it is with the small test pieces and no agitation.

Cross-respondent based its proofs of infringement upon tests made on samples of the acid used by cross-petitioner in treating certain wells. Although portions of the same samples were given to cross-petitioner, it never offered any evidence based on these samples to contradict cross-respondent's proofs or for any other purpose. Thus, there is no evidence in the record to negative cross-respondent's proofs that such samples were hydrochloric acid of about 15% concentration and were so inhibited that their corrosiveness was reduced 42 to 70 per cent. (R. 1705.) Cross-petitioner readily could have made tests of the acid it was using by taking portions thereof from its own acid truck tanks, but this it never elected to do. (R. 874-875.)

While cross-petitioner contends that its acid is not inhibited, it never offered evidence of any tests of its acid to support its contention. Obviously, had cross-petitioner's acid not been inhibited, this could have been proven by simple tests.

3. Cross-Petitioner's Treating Acid Is Introduced Into the Well Through the Regular Pump Tubing

At the well being treated cross-petitioner connects its truck tank to the well tubing by means of a hose connection through which the acid, inhibited as above explained, is pumped from the truck tank into the well tubing and through it into the well. (R. 287-290.)

4. Pressure Is Applied to the Acid in the Pump Tubing

Cross-petitioner expels the acid from the tubing and forces it out into the producing formation by means of a

pressure pump which in the wells relied on to prove infringement created pressures up to 700 pounds per square inch at the head of the tubing. (R. 278, 1815, 1818 and 1820.)

5. Withdrawal of the Spent Acid

The spent acid is withdrawn from the well either by swabbing or as the well is put back on production. (R. 279-89.)

CROSS-PETITIONER'S PROCESS INFRINGES

Under many decisions of this court, a few of which we have cited at page 62, *supra*, the concurrent findings of the District Court and the Circuit Court of Appeals should settle the question of infringement, and preclude the necessity for further consideration thereof. The District Court found that cross-petitioner inhibits its acid "by the presence in the acid of dissolved lead and copper" and that it treats oil wells "by charging into the well tube, by means of a pump, an inhibited hydrochloric acid solution of about fifteen per cent concentration, expelling such acid solution into the base of the well to act upon the rock formation surrounding the well cavity, and withdrawing the spent acid." (Fact findings 83 and 84, R. 1490.) These findings are fully supported by the proofs and establish infringement of even the most limited of the claims in suit.

In concurring in the finding of infringement the Court of Appeals stated (R. 2054):

> "An acid solution of about fifteen per cent concentration is used by the appellee, and when the acid is inserted in the tubing of the well, the copper, lead and iron chlorides therein act to reduce corrosion from forty to sixty per cent. Although no chemical action is present between the hydrochloric acid and the arsenic compounds which are used by appellant as inhibitors (in the specific example of the patent), as

is the case in appellee's process, the District Court found, we think correctly, that appellee infringes if the patent is valid."

The average metal content of the samples of cross-petitioner's storage acid, diluted to the strength of its treating acid, was copper 0.46 parts per million, lead 4.7 p.p.m., and iron 8.9 p.p.m. (R. 1712, Exhibit 162), whereas in cross-petitioner's treating acid sampled at the wells these metals were increased to copper 3.8 p.p.m.; lead 302 p.p.m.; iron 354 p.p.m. (R. 1711.) Copper was thus increased more than eight-fold and lead more than seventy-fold. The average reduction in corrosiveness of cross-petitioner's treating acid, as compared with chemically pure acid, was 52%, while its storage acid was on the average only 8.3% less corrosive than the pure acid. (R. 1705, 1709.) These figures were obtained with 50 c.c. samples of acid, without agitation, using strap iron strips as test pieces. Increasing the volume of acid proportionately to the size of the test piece and also agitating the acid during the test still further reduced corrosiveness. (*Supra*, p. 67.) These results were corroborated by tests made by Dr. Prutton. (*Supra*, pp. 68, 69.)

This increase in copper and lead in cross-petitioner's treating acid over that in its storage acid, and the resulting reduction in corrosiveness, is due to the action on the acid of cross-petitioner's specially equipped truck tanks. (Fact Findings 86-90, R. 1491.)

The corrosiveness of cross-petitioner's acid was reduced an average of 42.5% in the two Stella Wilcox treatments, 42% in the Zahn treatment, and 70% in the Crawford well treatment. (R. 1705.) The acid used in these wells was, therefore, only 58% to 30% as corrosive as uninhibited 15% acid, which is only 20% as corrosive as the acid used

by Frasch.[42] Cross-petitioner has thus reduced the corrosiveness of its acid to about 6% to 12% of that of Frasch's acid. Cross-petitioner's dilute inhibited acid is thus manifestly not the concentrated corrosive uninhibited acid of the prior art.

The Claims in Suit

The most limited of the claims in suit are Nos. 8 and 9. They are in the same terms except that claim 9 includes near the end the words "under pressure due to the gas generated thereby." The testimony does not touch upon this clause, but it was explained that the reaction between hydrochloric acid and limestone forms a gas, and if this reaction occurs in the oil-producing stratum it is inevitable that the acid will "act upon the rock formation surrounding the well cavity *under pressure due to the gas generated thereby,*" as called for by the claim.

Claim 8 reads as follows:

> "The method for increasing the output of an oil well which comprises
>
> (a) charging into the pump tube a quantity of a 5 to 15 per cent hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor,
>
> (b) expelling the acid from the tube into the bore of the well by applying pressure thereon,
>
> (c) permitting the acid to act upon the rock formation surrounding the well cavity and
>
> (d) withdrawing the spent acid."

Claim 7 is slightly broader than claim 8. It is quoted as illustrative in the opinion of Judge McDermott. The last two clauses are the same as clauses (c) and (d)

---

(42) PX-343 (R. 1802) gives the corrosion rate of 27.5% HCl (Frasch acid R. 1889) on steel as 1.36 lbs. per sq. foot per day and that of 15% acid as 0.27 lbs. per sq. foot per day or about 1/5 that of 27.5% acid.

of claim 8 and in place of clauses (a) and (b) is the following single clause:

> "introducing into the base of such well a 5 to 20% hydrochloric acid solution containing a relatively small amount of a corrosion inhibitor,"

thus the acid need not be introduced through the well tubing in order to infringe claim 7.

Claim 1 is the broadest and covers a method of increasing the output of a well for producing a fluid mineral product

> "which consists in introducing into the well an aqueous hydrochloric acid solution to which has been added a relatively small amount of an agent capable of inhibiting the action of the acid upon metals."

The language of this claim differs from each of the other claims in suit in that it calls for the use of a hydrochloric acid solution to which the inhibitor "has been added," whereas the other claims call for the use of a hydrochloric acid solution which *contains* an inhibitor.

The District Court considered the formation of the inhibiting agents—copper and lead—by chemical reaction between the acid and lead plates in cross-petitioner's truck tanks to be the equivalent of *adding* the inhibitor to the acid, and held this claim infringed along with the others, the essential feature being the presence of the inhibitor in the acid when it is placed in the well.

RELIEF

We respectfully submit that the decree should be reversed insofar as it relates to the validity of the Grebe and Sanford patent No. 1,877,504, and that the District Court be directed to enter a decree finding said patent valid and infringed and granting the usual relief.

Respectfully submitted,

Russell Wiles,
Wilber Owen,
Counsel for Petitioner and Cross-Respondent.

Chritton, Wiles, Davies, Schroeder & Merriam,
Board of Trade Building,
Chicago, Illinois,
Owen & Owen,
Nicholas Building,
Toledo, Ohio
Calvin A. Campbell,
Don L. Conner,
Midland, Michigan,
Attorneys for Petitioner and Cross-Respondent.